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# URANIUM IN U.S. SURFACE, GROUND, AND DOMESTIC WATERS VOLUME 1

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# URANIUM IN U.S. SURFACE, GROUND, AND DOMESTIC WATERS

## Volume 1

J. S. Drury, S. Reynolds, P. T. Owen, R. H. Ross, and J. T. Ensminger

Dr. C. R. Cothern

Health and Environmental Studies Program
Information Center Complex

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16. ABSTRACT

This report summarizes published information concerning the concentrations of uranium in 89 994 U.S. surface, ground, and domestic waters. Sources surveyed included the open literature, state health departments, federal agencies, and personal contacts. For each state, samples were geographically located, identified by type and use, and tabulated by decreasing uranium concentration. Histograms covering 14 concentration ranges were prepared for all surface, ground, and domestic water samples of each state and for the entire United States. Estimates were made of the population-weighted average concentrations of uranium in domestic waters of each state. Based on these averages, alpha radiation bone doses were computed for lifetime consumptions of each water. In addition, the fractions of water supplies in each state producing water containing uranium in excess of 1, 5, 10, and 20 pCi/L were estimated. An extensive discussion of analytical methods used to determine uranium in surface and ground waters was also included.

The concentrations of uranium in 34 561 U.S. surface waters ranged from 0.01 to 582.38 pCi/L and averaged 1.06 pCi/L. In 55 433 U.S. ground water samples the concentrations of uranium ranged from 0.01 to 652.80 pCi/L and averaged 3.18 pCi/L. Uranium in 28 239 domestic water sources ranged from 0.07 to 652.80 pCi/L and averaged 1.73 pCi/L. The population-weighted average concentration of uranium in U.S. domestic waters was estimated to be 0.8 pCi/L.

17. KEY WORDS AND DOCUMENT ANALYSIS

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# ABSTRACT

This report summarizes published information concerning the concentrations of uranium in 89 994 U.S. surface, ground, and domestic waters. Sources surveyed included the open literature, state health departments, federal agencies, and personal contacts. For each state, samples were geographically located, identified by type and use, and tabulated by decreasing uranium concentration. Histograms covering 14 concentration ranges were prepared for all surface, ground, and domestic water samples of each state and for the entire United States. Estimates were made of the population-weighted average concentrations of uranium in domestic waters of each state. Based on these averages, alpha radiation bone doses were computed for lifetime consumptions of each water. In addition, the fractions of water supplies in each state producing water containing uranium in excess of 1, 5, 10, and 20 pCi/L were estimated. An extensive discussion of analytical methods used to determine uranium in surface and ground waters was also included.

The concentrations of uranium in 34 561 U.S. surface waters ranged from 0.01 to 582.38 pCi/L and averaged 1.06 pCi/L. The median and modal concentration ranges for these samples were 0.1 to 0.2 pCi/L and 0.2 to 0.5 pCi/L, respectively. In 55 433 U.S. ground water samples the concentrations of uranium ranged from 0.01 to 652.80 pCi/L and averaged 3.18 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L and 2 to 5 pCi/L, respectively. Of the listed sample sites 28 239 were identified as domestic water sources. Uranium in these samples ranged from 0.07 to 652.80 pCi/L and averaged 1.73 pCi/L. The median and modal concentration ranges for these samples were identical, 0.1 to 0.2 pCi/L. The population-weighted average concentration of uranium in U.S. domestic waters was estimated to be 0.8 pCi/L. Based on this value, the average lifetime U.S. alpha radiation bone dose due to uranium in drinking water was estimated as 12 mrem/year for one model and <1 mrem/year for a second model. Using state totals, we estimated that 15% to 24% of all U.S. water supplies would have uranium concentrations in excess of 1 pCi/L; 4% to 8%, in excess of 5 pCi/L; 0.1% to 3%, in excess of 10 pCi/L; and 0.04% to 1%, in excess of 20 pCi/L.

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# SUMMARY

Uranium can be found at picocurie per liter (pCi/L) levels in most U.S. surface and ground waters and may exceed 600 pCi/L in selected samples. It is generally present at higher concentrations in U.S. ground waters (modal concentration range for 55 433 samples, 2 to 5 pCi/L) than in U.S. surface waters (modal concentration range for 34 561 samples, 0.2 to 0.5 pCi/L). Waters used for domestic purposes (i.e., for human consumption) tend to have somewhat less uranium than the average U.S. surface or ground water sample (modal concentration range for 28 239 samples, 0.1 to 0.2 pCi/L). Estimated population-weighted average concentrations of uranium in domestic waters of the various states ranged from <0.1 pCi/L to 6.7 pCi/L. Twenty states (counting the District of Columbia) have estimated population-weighted average concentrations equal to or less than 0.1 pCi/L, and 39 states have estimated population-weighted average concentrations equal to or less than 1 pCi/L. The 12 remaining states that have appreciably higher average concentrations of uranium in domestic water are all located west of the Mississippi River. These states and their estimated population-weighted average concentrations of uranium (pCi/L) are as follows: South Dakota, 6.7; Nevada, 4.3; New Mexico, 2.9; California, 2.7; Wyoming, 2.7; Texas, 2.6; Arizona, 2.5; Oklahoma, 2.5; Colorado 1.8; Nebraska, 1.8; Montana, 1.4; and Kansas 1.2. Obviously, these 12 states also have the highest estimated lifetime alpha radiation bone doses due to uranium in drinking water. These estimated bone doses ranged from 18 mrem/year (Kansas) to 101 mrem/year (South Dakota) for Model I and <1 mrem/year to 4 mrem/year, respectively, for Model II.

Based on the tabulated data, 15% to 24% of all U.S. water supplies were estimated to have concentrations of uranium exceeding 1 pCi/L; 4% to 8%, in excess of 5 pCi/L; 0.1% to 3%, in excess of 10 pCi/L; and 0.04% to 1%, in excess of 20 pCi/L.

Statistics for individual states are summarized in Table 1.

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Table 1. Summary of uranium occurrence data

| State | Population 1970 census (millions) | Population-weighted average concentration of uranium in domestic water (pCi/L) | Estimated percent of water supplies with concentration of uranium exceeding (pCi/L): 1 | 5 | 10 | 20 | Domestic water: Number of samples | Domestic water: Uranium concentration Range (pCi/L) | Domestic water: Uranium concentration Mode (pCi/L) | Surface water: Number of sampled | Surface water: Uranium concentration Range (pCi/L) | Surface water: Uranium concentration Mode (pCi/L) | Ground water: Number of samples | Ground water: Uranium concentration Range (pCi/L) | Ground water: Uranium concentration Mode (pCi/L) | Estimated worst case lifetime alpha radiation bone dose (mrem/year) Model I | Model II |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 3.4 | <0.1 | 1–9 | 0 | 0 | 0 | 404 | 0.01–3 | 0.01 | 6 | 0.07–2 | 0.05–0.1 | 415 | 0.01–3 | 0.01 | 1 | <1 |
| Alaska | 0.3 | 0.3 | 0–6 | 0–0.3 | 0–0.04 | 0 | | | | 7681 | 0.01–13 | 0.2–0.5 | | | | 5 | <1 |
| Arizona | 1.8 | 2.5 | 65–70 | 0–24 | 0–15 | 0–8 | 214 | 0.01–339 | 2–5 | 21 | 0.05–5 | 0.5–1 | 583 | 0.01–339 | 2–5 | 37 | 1 |
| Arkansas | 1.9 | <0.1 | 0 | 0 | 0 | 0 | 5 | 0.07–0.2 | 0.05–0.1 | 259 | 0.01–2 | 0.1–0.2 | 5 | 0.07–0.2 | 0.05–0.1 | 1 | <1 |
| California | 20.0 | 2.7 | 56–93 | 0–16 | 0–8 | 0–8 | 25 | 0.07–449 | 2–5 | 7 | 0.07–6 | 2–5 | 39 | 0.07–449 | 1–2 | 41 | 2 |
| Colorado | 2.2 | 1.8 | 6–46 | 0–10 | 0–5 | 0–2 | 199 | 0.01–122 | 1–2 | 6225 | 0.01–582 | 0.2–0.5 | 7328 | 0.01–509 | 2–5 | 27 | 1 |
| Connecticut | 3.0 | 0.2 | 0–15 | 0–3 | 0–2 | 0–0.4 | 734 | 0.01–27 | 0.02–0.05 | 608 | 0.01–8 | 0.01 | 750 | 0.01–27 | 0.02–0.05 | 4 | <1 |
| Delaware | 0.5 | 0.3 | 0 | 0 | 0 | 0 | 4 | 0.07–1 | | | | | 4 | 0.07–1 | | 4 | <1 |
| District of Columbia | 0.8 | <0.1 | 0 | 0 | 0 | 0 | 1 | | 0.05–0.1 | 1 | | 0.05–0.1 | | | | 1 | <1 |
| Florida | 6.8 | 0.6 | 10–13 | 0–1 | 0 | 0 | 84 | 0.02–7 | 0.5–1 | | | | 86 | 0.02–7 | 0.5–1 | 9 | <1 |
| Georgia | 4.6 | <0.1 | 0–3 | 0–0.7 | 0–0.4 | 0–0.2 | 1646 | 0.01–288 | 0.01 | 5 | 0.07–0.3 | 0.2–0.5 | 1695 | 0.01–288 | 0.01 | <1 | <1 |
| Hawaii | 0.8 | <0.1 | 0 | 0 | 0 | 0 | 3 | 0.07–0.07 | 0.05–0.1 | | | | 3 | 0.07–0.07 | 0.05–0.1 | <1 | <1 |
| Idaho | 0.7 | 0.8 | 0–13 | 0–3 | 0 | 0 | 42 | 0.02–73 | 0.5–1 | 149 | 0.01–54 | 0.2–0.5 | 167 | 0.01–73 | 0.02–0.05 | 11 | <1 |
| Illinois | 11.1 | 0.3 | 0 | 0 | 0 | 0 | 10 | 0.07–0.5 | 0.2–0.5 | 3 | 0.07–0.2 | 0.05–0.1 | 8 | 0.07–1 | 0.2–0.5 | 5 | <1 |
| Indiana | 5.2 | 0.6 | 0 | 0 | 0 | 0 | 12 | 0.07–1 | 0.5–1 | 5 | 0.07–1 | 0.5–1 | 12 | 0.07–1 | 0.2–0.5 | 10 | <1 |
| Iowa | 2.8 | 0.5 | 26–29 | 0 | 0 | 0 | 7 | 0.07–4 | 0.2–0.5 | 1 | | 1–2 | 9 | 0.07–4 | 0.2–0.5 | 7 | <1 |
| Kansas | 2.2 | 1.2 | 40–60 | 0–12 | 0–5 | 0–2 | 1411 | 0.03–121 | 1–2 | 28 | 0.07–188 | 0.05–0.1 | 2318 | 0.01–121 | 2–5 | 18 | <1 |
| Kentucky | 3.2 | 0.1 | 20 | 0 | 0 | 0 | 10 | 0.07–2 | 0.05–0.1 | 63 | 0.01–0.9 | 0.01 | 394 | 0.01–2 | 0.01 | 2 | <1 |
| Louisiana | 3.6 | <0.1 | 0 | 0 | 0 | 0 | 18 | 0.07–0.3 | 0.05–0.1 | 4 | 0.07–0.1 | 0.05–0.1 | 14 | 0.07–0.3 | 0.05–0.1 | 1 | <1 |
| Maine | 1.0 | 0.2 | 0–13 | 0–7 | 0–4 | 0–4 | 191 | 0.01–653 | 0.02–0.05 | 404 | 0.01–3 | 0.01 | 200 | 0.01–653 | 0.02–0.05 | 3 | <1 |
| Maryland | 3.9 | <0.1 | 0 | 0 | 0 | 0 | 9 | 0.07–0.7 | 0.05–0.1 | 2 | 0.07–0.07 | 0.05–0.1 | 8 | 0.07–0.7 | 0.05–0.1 | 1 | <1 |
| Massachusetts | 5.7 | <0.1 | 0–8 | 0–0.6 | 0–0.3 | 0 | 308 | 0.01–15 | 0.01 | 639 | 0.01–12 | 0.01 | 321 | 0.01–15 | 0.01 | <1 | <1 |
| Michigan | 8.9 | 0.2 | 0–28 | 0–8 | 0–5 | 0–5 | 39 | 0.01–68 | 0.2–0.5 | 11 | 0.01–1 | 0.1–0.2 | 43 | 0.01–68 | 0.2–0.5 | 3 | <1 |
| Minnesota | 3.8 | 0.2 | 14–29 | 0–9 | 0–4 | 0–1 | 1351 | 0.01–68 | 0.1–0.2 | 18 | 0.07–0.6 | 0.2–0.5 | 1448 | 0.01–68 | 0.1–0.2 | 2 | <1 |
| Mississippi | 2.2 | <0.1 | 0 | 0 | 0 | 0 | 7 | 0.07–0.07 | 0.05–0.1 | 1 | | 0.05–0.1 | 6 | 0.07–0.07 | 0.05–0.1 | 1 | <1 |
| Missouri | 4.7 | 0.3 | 0–6 | 0 | 0 | 0 | 65 | 0.11–3 | 0.1–0.2 | 362 | 0.01–26 | 0.1–0.2 | 602 | 0.01–45 | 0.01 | 4 | <1 |
| Montana | 0.7 | 1.4 | 53–80 | 0–18 | 0–10 | 0–3 | 62 | 0.07–31 | 1–2 | 4818 | 0.01–155 | 0.2–0.5 | 1658 | 0.01–85 | 1–2 | 20 | <1 |
| Nebraska | 1.5 | 1.8 | 78–88 | 0–28 | 0–17 | 0 | 18 | 0.14–15 | 1–2 | 5 | 0.03–33 | 1–2 | 122 | 0.01–67 | 2–5 | 27 | 1 |
| Nevada | 0.5 | 4.3 | 66–100 | 15–100 | 0–3 | 0 | 99 | 0.03–14 | 1–2 | 200 | 0.01–9 | 2–5 | 965 | 0.01–122 | 1–2 | 65 | 2 |
| New Hampshire | 0.7 | <0.1 | 0–10 | 0–2 | 0–1 | 0–0.4 | 491 | 0.01–65 | 0.02–0.05 | 1013 | 0.01–8 | 0.01 | 548 | 0.01–65 | 0.02–0.05 | <1 | <1 |
| New Jersey | 7.2 | 0.1 | 0–6 | 0 | 0 | 0 | 135 | 0.01–5 | 0.01 | 99 | 0.01–2 | 0.01 | 144 | 0.01–5 | 0.01 | 2 | <1 |
| New Mexico | 1.0 | 2.9 | 43–62 | 0–12 | 0–5 | 0–2 | 102 | 0.04–45 | 2–5 | 1142 | 0.01–234 | 0.2–0.5 | 3806 | 0.01–464 | 2–5 | 44 | 2 |
| New York | 18.2 | 0.3 | 9–10 | 0–2 | 0–0.4 | 0 | 1109 | 0.01–19 | 0.02–0.05 | 1404 | 0.01–10 | 0.01 | 1142 | 0.01–19 | 0.02–0.05 | 4 | <1 |

Table 1 (continued)

| State | Population 1970 census (millions) | Population-weighted average concentration of uranium in domestic water (pCi/L) | Estimated percent of water supplies with concentration of uranium exceeding (pCi/L): | | | | Domestic water | | | Surface water | | | Ground water | | | Estimated worst case lifetime alpha radiation bone dose (mrem/year) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 5 | 10 | 20 | Number of samples | Uranium concentration Range (pCi/L) | Uranium concentration Mode (pCi/L) | Number of samples | Uranium concentration Range (pCi/L) | Uranium concentration Mode (pCi/L) | Number of samples | Uranium concentration Range (pCi/L) | Uranium concentration Mode (pCi/L) | Model I | Model II |
| North Carolina | 5.1 | <0.1 | 0–3 | 0–0.9 | 0–0.4 | 0–0.2 | 1444 | 0.01–89 | 0.01 | 2 | 0.07–0.07 | 0.05–0.1 | 1917 | 0.01–89 | 0.02–0.05 | 1 | <1 |
| North Dakota | 0.6 | 0.3 | 0 | 0 | 0 | 0 | 7 | 0.07–1 | 0.2–0.5 | | | | 8 | 0.07–1 | 0.2–0.5 | 5 | <1 |
| Ohio | 10.7 | <0.1 | 9–18 | 0 | 0 | 0 | 17 | 0.07–1 | 0.05–0.1 | 75 | 0.07–1 | 0.2–0.5 | 10 | 0.07–1 | 1–2 | 1 | <1 |
| Oklahoma | 2.6 | 2.5 | 50–53 | 17–20 | 0–9 | 0–4 | 2818 | 0.01–120 | 0,1–0.2 | 2 | 0.14–0.2 | 0.2–0.5 | 3445 | 0.01–120 | 0.1–0.2 | 38 | 1 |
| Oregon | 2.1 | <0.1 | 0 | 0 | 0 | 0 | 6 | 0.07–0.5 | 0.05–0.1 | 1 | | 0.1–0.2 | 6 | 0.07–0.5 | 0.2–0.5 | 1 | <1 |
| Pennsylvania | 11.8 | <0.1 | 2–5 | 0–0.3 | 0–0.07 | 0 | 2772 | 0.01–15 | 0.01 | 2477 | 0.01–12 | 0.01 | 3239 | 0.01–15 | 0.01 | 1 | <1 |
| Rhode Island | 0.9 | 0.1 | 0 | 0 | 0 | 0 | 4 | 0.07–1 | 0.05–0.1 | 1 | | 0.05–0.1 | 4 | 0.07–1 | 0.5–1 | 2 | <1 |
| South Carolina | 2.6 | 0.2 | 2–54 | 0–0.3 | 0–0.2 | 0–0.1 | 2361 | 0.01–57 | 0.02–0.05 | 2 | 0.03–0.05 | | 2448 | 0.01–57 | 0.02–0.05 | 3 | <1 |
| South Dakota | 0.7 | 6.7 | 78–83 | 55–83 | 0–31 | 0–12 | 51 | 0.07–130 | 5–10 | 264 | 0.01–4 | 0.1–0.2 | 86 | 0.07–130 | 5–10 | 101 | 4 |
| Tennessee | 3.9 | <0.1 | 0 | 0 | 0 | 0 | 182 | 0.01–0.8 | 0.01 | 168 | 0.01–1 | 0.01 | 747 | 0.01–13 | 0.01 | 1 | <1 |
| Texas | 11.2 | 2.6 | 39–47 | 7–16 | 3–7 | 2–3 | 6320 | 0.01–356 | 0.1–0.2 | 1169 | 0.01–105 | 0.1–0.2 | 10367 | 0.01–356 | 0.1–0.2 | 39 | 1 |
| Utah | 1.1 | 0.5 | 20–33 | 0 | 0 | 0 | 15 | 0.07–4 | 0.5–1 | 260 | 0.01–300 | 0.2–0.5 | 348 | 0.01–117 | 0.5–1 | 8 | <1 |
| Vermont | 0.4 | <0.1 | 0–9 | 0–2 | 0–0.5 | 0 | 375 | 0.01–15 | 0.01 | 699 | 0.01–6 | 0.01 | 396 | 0.01–15 | 0.01 | 1 | <1 |
| Virginia | 4.7 | <0.1 | 0–3 | 0–0.6 | 0–0.5 | 0–0.3 | 641 | 0.01–496 | 0.02–0.05 | 3 | 0.07–0.1 | 0.05–0.1 | 1032 | 0.01–496 | 0.02–0.05 | 1 | <1 |
| Washington | 3.4 | 0.6 | 10–41 | 0–10 | 0–3 | 0–1 | 80 | 0.01–27 | 0.5–1 | 2 | 0.07–0.1 | 0.1–0.2 | 170 | 0.01–40 | 0.5–1 | 9 | <1 |
| West Virginia | 1.7 | 0.7 | 20–33 | 0 | 0 | 0 | 5 | 0.07–1 | 0.5–1 | 0 | | | 6 | 0.07–9 | 0.5–1 | 11 | <1 |
| Wisconsin | 4.4 | 0.2 | 3–9 | 0–2 | 0–0.6 | 0–0.4 | 2251 | 0.01–68 | 0.01 | 1966 | 0.01–68 | 0.01 | 2500 | 0.01–68 | 0.01 | 3 | <1 |
| Wyoming | 0.3 | 2.7 | 50–80 | 0–29 | 0–16 | 0–9 | 74 | 0.07–68 | 2–5 | 2288 | 0.01–305 | 0.2–0.5 | 3658 | 0.01–203 | 2–5 | 41 | 2 |
| United States | 33.3 | 0.8 | 15–24 | 4–8 | 0.1–3 | 0.04–1 | 28239 | 0.01–653 | 0.1–0.2 | 34561 | 0.01–582 | 0.2–0.5 | 55433 | 0.01–653 | 2–5 | 12 | <1 |

# 1. INTRODUCTION

This study summarizes available data on the concentrations of uranium in surface, ground, and domestic waters of each of the 50 states and the District of Columbia. The study was prepared for the Office of Drinking Water (ODW), U.S. Environmental Protection Agency (EPA), by personnel from the Health and Environmental Studies Program (HESP) of the Information Center Complex, Information Division, Oak Ridge National Laboratory (ORNL), and by personnel from ORNL's Analytical Chemistry Division. Because the purpose of these studies was to assist EPA in establishing standards for drinking water, the focus was on uranium in waters used for human consumption, such as treated waters from municipal water purification plants. However, relatively few treated waters have been analyzed for uranium; consequently, the scope of the report was extended to cover concentrations of uranium in surface and ground waters whether or not these waters were designated as potable sources.

Most of the published analyses of uranium in U.S. waters are the result of the National Uranium Resource Evaluation (NURE) program, which had as its objectives the evaluation of domestic uranium resources and the identification of areas favorable to uranium exploration. As part of this program, during the latter part of the 1970s, samples were taken of surface and ground waters over much of the continental United States, including Alaska, at a rate of one sample per 10 to 15 square kilometers. Because the NURE program was concerned with the discovery of uranium ore deposits, rather than with health effects, most of the surface and ground water samples were unrelated to potable water sites or were not so identified. However, some sample sites were identified as domestic or municipal water sources. Analyses of samples from these sites constitute the major source of published information on uranium in U.S. drinking waters.

Other analyses of uranium in water were obtained from searches of computerized data files and from contacts with personnel in the health departments of various states and in certain government agencies such as the Office of Radiation Programs, U.S. Environmental Protection Agency, Montgomery, Alabama (Appendix 1).

Data characterizing the location, sampling criteria, type, use, and uranium concentrations of individual samples are recorded in tabular form in volumes 2, 3, and 4 of this report. These data are segregated by state and arranged in decreasing order of uranium concentration. The tabular data in volumes 2, 3, and 4 are summarized in volume 1 in narrative form and with maps and histograms. For maximum usefulness, different types of water are characterized separately. Thus, statistical data are provided not only for surface and ground waters, but also for domestic waters and treated waters from municipal water purification plants. The latter two categories are not synonymous. Much domestically consumed water comes from municipal water supplies with little or no treatment. In volume 1, the domestic water category includes all samples identified for human consumption regardless of source. On the other hand, the category "treated water from municipal water purification plants" encompasses only waters known to have received treatment in municipal plants. Only a limited amount of data were available in the latter category, but, since standard municipal water treatment procedures may alter the uranium content of processed water, it was considered worthwhile to display these data separately.

Maps are provided in volume 1 to indicate sample locations and extent of coverage. The striped areas shown on these maps indicate areas covered by NURE surveys in which water samples were taken systematically at distance intervals approximating 5 km. The dots on each state map indicate approximate locations of non-NURE samples. Most of the indicated non-NURE samples were taken during the 1960s and may be thought outdated now; but, whenever recent samples from such sites were available for comparison, we observed a high degree of correspondence between recent and early samples. Consequently, we believe that inclusion of the early data is warranted, particularly because they represent the only available information in many instances.

The tabular data in volumes 2, 3, and 4 are summarized in volume 1 with histograms showing the frequency of occurrence of surface, ground, and domestic water samples in each of 14 concentration ranges. The bars of the histograms represent the number of samples falling into a range defined by the concentration under the bar and the adjacent concentration to the left.

to the left. It should be noted that the maximum, minimum, and mean indicated for each histogram are truncated values, rather than rounded values; consequently, maximum, minimum, and mean values given in the histogram may differ by one unit in the last digit from the correctly rounded values cited in the text. It should also be noted that in computing the histograms, samples containing concentrations of uranium below the limit of detection were arbitrarily assigned a value corresponding to the published limit of detection for the designated analytical method. Neither of these approximations significantly biases the reported results.

Standard techniques for sampling and determining uranium in freshwaters are discussed in Sect. 2 of volume 1. These criteria were used to assess the analytical quality of data collected in this study. Analyses lacking evidence of good quality control were not included in this report.

In addition to uranium concentrations, ODW requested estimates of lifetime bone doses of alpha particle radiation likely to be incurred by the population consuming the sampled water. Such estimates are strongly dependent on assumptions made concerning uptake, transport, excretion, and deposition of uranium in vivo. Furthermore, if the sampled water is treated before consumption, human uptake of uranium will obviously vary inversely with the extent of uranium removal that occurs during the treatment process. Estimates of lifetime bone doses are thus subject to numerous qualifying conditions. Nevertheless, estimates of bone doses based on two different models have been supplied, as requested, for each sample. The main assumptions associated with each model are described in Appendix 3 of volume 1.

Other information requested by ODW included population-weighted average uranium concentrations of the drinking waters of each state and, for each state, the percent of water supplies having uranium concentrations exceeding 1, 5, 10, and 20 pCi/L. Analytical data needed to determine these requirements rigorously could not be found; however, it was possible to prepare best estimates for both requirements, utilizing available data and certain generalized assumptions. The procedures involved in these estimates are discussed in Appendixes 2 and 4, respectively, of volume 1.

# 2. ANALYSIS FOR URANIUM IN FRESHWATER

## 2.1 INTRODUCTION

### 2.1.1 Behavior of Uranium in Water

The forms of uranium in water have been extensively discussed [141, 169,171]. Uranium may exist in valence states of 3+, 4+, 5+, and 6+, in the form of the ions $U^{3+}$, $U^{4+}$, $UO_2^+$, and $UO_2{}^{2+}$. The $U^{3+}$ ion would decompose water, and $UO_2^+$ is unstable with respect to disproportionation and air oxidation; so these species are of little or no importance. The $U^{4+}$ ion is converted to $UO_2{}^{2+}$ by dissolved oxygen or other oxidants. However, under reducing conditions characteristic of some ground waters, $U^{4+}$ is stable and can be lost from solution by hydrolysis and sorption by surfaces. Felmlee and Cadigan [16] have shown a correlation between the uranium concentration and redox potential (Eh). In many natural waters, the dominant form of $U^{6+}$ is the carbonate complex $UO_2(CO_3)_3{}^{4-}$, which remains in solution. Further, the hydrolysis and sorption of $U^{6+}$ in the absence of carbonate are less pronounced than for $U^{4+}$, but sorption to sediments can occur [199]. Suspended particles may therefore contain a substantial fraction of the uranium in a water sample [166], both sorbed and included in mineral matter. Zielinski and Rosholt [9] report that the uranium content of oxygenated filtered water samples appears to be reasonably stable, but Kepak [181] shows losses to glass and platinum containers.

### 2.1.2 Principles of Analysis

Methods of measurement of uranium have been described in general terms [150,168,171,199]. Levels of uranium in water samples are generally too low to be measured by spectrographic, titrimetric, or electrometric methods. Trace analysis methods are listed briefly here and are described in more detail in following sections. They are generally sensitive to microgram and submicrogram amounts of uranium. Methods used in the NURE program are emphasized, but other significant ones are also discussed and referenced. In many cases, samples must be concentrated, and often uranium must be separated from other materials. The following section summarizes some methods of accomplishing this. Uranium mass concentrations are usually reported in micrograms per liter (μg/L), equivalent (in the United States) to parts per billion (ppb). Note that 1 ppb is $4 \times 10^{-9}$ *M*. Radioactivity is often reported in picocuries per liter. A picocurie is 2.22 disintegrations per minute (the SI unit of radioactivity is the becquerel, Bq, one disintegration per second). The relationship between radioactivity and mass for uranium of normal isotopic composition is 0.68 pCi/μg.

One of the most important analytical techniques is measurement of uranium fluorescence in a fused pellet irradiated by ultraviolet light [137,157]. A recent development involves laser-excited fluorescence in solution [209].

Determination of uranium by neutron activation analysis usually involves counting delayed neutrons following fission of the $^{235}U$ isotope by neutrons in a nuclear reactor [162]. Radioactivity from radionuclides produced by fission of $^{235}U$ or neutron capture in $^{238}U$ can also be used to determine uranium [182]. Mass spectrometry is a useful technique for traces of uranium [165,187], capable of great sensitivity and precision. Uranium alpha radioactivity is measured by a gas-filled or solid-state counter [140] or by a spectrometer following appropriate radiochemical separation [171,183].

The uncertainty of quantitative recovery or instrument response in trace analysis makes the use of standard additions, or "spikes," very common. Known amounts of uranium are added to samples after initial measurements by laser-excited fluorescence [208]. The isotope dilution technique — adding a known quantity of a particular isotope to a sample — is used in both mass spectrometric [165] and radiochemical determinations [172].

### 2.1.3 Concentration and Separation

Some generalities on concentration and separation techniques have been reported [150,171,183,199]. Some of the reported techniques achieve only concentration, some only separation, and some both goals. Precautions must be taken so that uranium is not lost or that correction for loss is made (e.g., by spiking). The simplest concentration method is evaporation [172]. If the sample is not already acid, it should be made so before heating is begun. Uranium concentrations in water are so low that direct precipitation is not feasible. Coprecipitation with insoluble compounds is therefore used [183]. Examples of carriers are ferrous hydroxide [147], ferric hydroxide [178], aluminum phosphate [203], and, for $U^{4+}$, lanthanum fluoride [149]. Carbonate interferes with precipitation of $UO_2{}^{2+}$ and must be removed, usually by acidification and heating.

Various sorbents have been used to concentrate uranium. Among these were activated charcoal [151], silica gel [193], and cellulose [154]. Uranium has been concentrated by sorption on ion-exchange resins, either added, equilibrated, and filtered off or contained in a column. Sometimes uranium is determined directly on the resin (e.g., by x-ray fluorescence or neutron activation). Cation exchangers are not very often employed [171], but considerable use is made of anion exchangers [152, 183], mixed-bed exchangers [199], and chelating resins [175].

Solvent extraction has long been used for separation of uranium [150,171,183]. Organic phases have included ethers, esters, ketones, alcohols, organophosphorus compounds, amines, and others. Some concentration can be effected if the volume of the organic phase is smaller than the original aqueous or if back extraction ("stripping") can be done with a small volume.

### 2.1.4 Variations in Isotopic Composition

Natural uranium, for example that contained in a very old, unaltered mineral, contains the isotopes $^{238}U$, $^{235}U$, and $^{234}U$ in abundances (atomic percentages) of 99.28%, 0.72%, and 0.0054% [186]. The half-lives are, respectively, $4.47 \times 10^9$, $7.04 \times 10^8$, and $2.45 \times 10^5$ years. From these data the specific activities are calculated to be 0.33, 0.015, and 0.33 pCi/μg of natural uranium, for a total of 0.68 pCi/μg. The $^{234}U$ ion is a descendant of $^{238}U$, and they are in radioactive equilibrium (equal activities).

Several chemical elements which can occur in water may quench the fluorescence; among these are chromium, copper, iron, manganese, and silicon. Quenching materials must be removed by chemical separation or compensated for by spiking duplicate or similar samples with known quantities of uranium [203]. A calibration curve could be made in this way for analysis of a large number of similar samples. The chemical separation option in the American Society for Testing and Materials (ASTM) method involves extraction of uranium with methyl isobutyl ketone. The extract is added directly to the fluoride pellet. The inherent precision of the ASTM method appears to be about 20%, and the MDC is about 5 μg/L. Preconcentration of larger volumes would be required to lower the MDC as needed. Operational details were recommended by Centanni, Ross, and DeSesa [157], who used ethyl acetate extraction as a purification step. A method reported by Harley [174] is unusual in that a radioactive tracer, $^{232}U$, is used to determine recovery. Other methodologies, including those of the NURE project, are tabulated in Sect. 2.7. Typical precisions are 10% to 20%, with MDCs of 0.01 to 0.1 μg/L.

A laser-induced fluorescence system for direct determination of uranium in water has been described [209] and evaluated [208]. A pulsed nitrogen laser with emission at 337 nm is used to irradiate a sample. The fluorescence of a uranyl pyrophosphate complex has a maximum at about 500 nm and is delayed with respect to typical fluorescence caused by sample organic matter, which typically has a maximum at about 400 nm. Use of a time delay and a green filter minimizes the interference. A standard addition is made to offset any quenching effects. The MDC is about 0.005 μg/L, and precision at moderate levels is about 3%.

### 2.3.2 Neutron Activation

Most of the secondary neutrons arising from fission of $^{235}U$ by thermal neutrons are emitted promptly. About 1.6% of the fission events, however, give rise to nuclides, which undergo beta decay to other nuclides, which emit neutrons. The half-lives of these beta emitters range from about 2 to 55 s. A delayed-neutron analysis [142,162] is performed by irradiating a specimen for a short time (20 to 60 s) in a well thermalized neutron spectrum in a reactor. The specimen is then transferred (normally by a pneumatic system) to a neutron counter, and counts are taken after a delay of 10 to 20 s. Calibration is done with uranium standards, and blanks are evaluated using empty containers. Interferences are not commonly encountered. Possibly interfering thorium and transuranic elements are unlikely to be present in water samples. High levels of gamma activity induced in sample materials could interfere, but such materials are not normally present in freshwater. A NURE method [76,199] involves concentration of uranium from a water sample on a mixed-bed ion-exchange resin, followed by direct delayed-neutron assay, while another method [93,94,199] uses evaporation for concentration. Precisions are 5% to 10%, and MDCs are 0.02 to 0.05 μg/L.

Activation determinations can also be made by irradiating and counting $^{239}U$ or its daughter $^{239}Np$, produced by neutron capture in $^{238}U$, or by counting a product of the fission of $^{235}U$ (e.g., $^{140}Ba$, $^{132}Te$) [182]. These techniques have sensitivities comparable to or greater than delayed-neutron counting, but require more elaborate manipulation or equipment. A very sensitive technique involves the counting of tracks produced in an appropriate plastic by fission fragments from irradiated specimens [166]. Sensitivity is about 0.01 μg/L, and precision is of the order of 10%.

### 2.3.3 Mass Spectrometry

For trace uranium analysis, thermal emission mass spectrometry is normally used, with an instrument of one to four stages, employing pulse counting for ion detection [164,165,206]. The isotope dilution technique is used, in which a known quantity of $^{233}U$ or $^{236}U$ is added at the beginning of the procedure ($^{235}U$ may be used, with the assumption that the sample uranium is natural). A solution containing the uranium may be dried on the source filament [165], or the uranium may be sorbed on single ion-exchange resin beads [164,206]. Uranium content ($^{238}U$ plus $^{235}U$) is calculated from the ratios of $^{238}U$ and $^{235}U$ to the known spike. Spark source mass spectrometry has also been used [190].

Precision of isotope dilution mass spectrometry is about 4% to 20% at typical water levels (and much better at higher levels), and the MDC is about 0.003 µg/L [165]. On NURE samples, a precision of about 15% and a MDC of 0.02 µg/L were demonstrated [143,161].

### 2.3.4 Other Techniques

X-ray fluorescence shows promise as a simple and sensitive technique. Hathaway and James [175] reported sorption of uranium on a chelating ion-exchange resin, which was then dried and used as an x-ray target. Uranium has been determined spectrophotometrically with arsenazo-III after liquid-liquid extraction with a quaternary ammonium salt in xylene [144]. A method was described for analysis by polarography of a cyclohexane-trioctylphosphine oxide extract [160].

## 2.4 METHODS FOR DETERMINING URANIUM RADIOACTIVITY

### 2.4.1 Total Activity

A number of separation methods summarized by Gindler [171] can be applied to radiometric determination of total uranium alpha activity in water. Other methods, for example that reported by Harley [172], can be used for total uranium by omitting the tracer ("spike") and counting total alpha rather than performing alpha spectrometry. Recoveries must then be established by analyzing appropriate standards in an identical way. A representative method [203] involves coprecipitation with ferric hydroxide, dissolving in hydrochloric acid, sorbing uranium on anion resin, eluting, and evaporating the solution on a planchet for counting. Recovery was over 90%, and precision was about 7% for a single laboratory.

### 2.4.2 Isotopic Activity

As indicated earlier, mass spectrometry can be used for measurement of uranium content and isotopic abundances, with expression in radioactivity units when desired. However, the radioactivities of individual uranium isotopes are usually determined by alpha spectrometry after appropriate concentration and separation steps. Most spectrometry is done by use of silicon semiconductor surface-barrier detectors [138]. Thin, uniform deposits for spectrometry are usually prepared by electrodeposition on planchets [172]. Other methods of source preparation are used, such as evaporating an aqueous solution on a planchet [203], evaporating an organic extract [171], as is done for plutonium [195], and depositing a fine precipitate on a filter [149]. A liquid scintillation technique for alpha spectrometry has been developed [189].

An interesting radiochemical method is that described by Blanchard [149], in which uranium is extracted from 9 *M* hydrochloric acid with triisooctylamine-xylene, stripped into dilute nitric acid, reduced, coprecipitated with lanthanum fluoride, and deposited on a membrane filter. Another method, described by Harley [172], involves sorption from 7 *M* hydrochloric acid on an anion column, removal of contaminants by electrolysis with a mercury cathode, and electrodeposition on a planchet. Both these methods use a $^{232}U$ tracer. A third method is that of Sill, Puphal, and Hindman [196], which includes coprecipitation of $U^{4+}$ with barium sulfate, extraction with an amine solution, and electrodeposition.

Typical sensitivity for each isotope is on the order of 0.01 pCi/L [1,172], and precision is 10% or better for moderate levels [1,6].

## 2.5 QUALITY ASSURANCE

Analytical quality assurance (QA) has been treated in general terms in a number of publications [179,200,204]. Some QA practices applied to sampling were mentioned in Sect. 2.2. Standard addition is an important QA technique, and, as discussed before, is an integral part of some fluorometric, mass spectrometric, and radiometric methods. For spiking or for construction of calibration curves, standards of various isotopic compositions are available [191]. Artificial uranium isotopes may be obtained from Oak Ridge National Laboratory and other suppliers. Overall precision of some methods may be evaluated by repeated analysis of typical samples. An important factor in radiometric, activation, and pulse-counting mass spectrometric techniques is statistical variation in counting. Uncertainty of counting must be combined with other uncertainties for an overall estimate [158]. The minimum detectable amount is often estimated from the standard deviation of the observed blank or background, multiplied by a factor typically between 2.8 [140] and 4.66 [173].

Until recently, quality assurance in determination of uranium in water was handled by individual chemists or laboratories. Several interlaboratory programs have now been started, as indicated in a 1978 symposium [180]. By far the largest is that of the NURE project [176,199]. Standards of uranium in natural water at about 1, 10, and 100 μg/L are regularly submitted as blind controls to the participants in the program. Results are reported to the laboratories for corrective action if required; a typical report in the series from the Department of Energy's Ames Laboratory is that by D'Silva, Grabau, and Haas [159].

For over three years the Environmental Measurements Laboratory of the Department of Energy has submitted environmental quality assurance samples to Department of Energy contractors and tabulated their analytical results. Results in 1979 for uranium in water were taken from a report by Welford, Fisenne, and Sanderson [207]. Neither radiometric nor fluorometric results showed significant bias, and overall standard deviations were about 9% for the former and 23% for the latter. Mound Laboratory has performed an interlaboratory test of an isotopic method for EPA [147] and is conducting a similar test [148] of a total activity method (Sect. 2.4.1). Further, EPA is adding uranium to its intercomparison program previously described [202].

## 2.6 COMPARISON OF METHODS

### 2.6.1 Technical Aspects

The major methods described are all useful for uranium in water at environmental levels. This can be shown by considering precision and limits of measurement given in preceding sections and in Sect. 2.7. It is further demonstrated by comparisons of analyses done, for example, by fluorometry, laser fluorometry, and mass spectrometry [208] and by neutron activation and fluorometry [170]. Quality control samples in the NURE program also show the comparability of the various techniques as practiced by the participants. The desired outcome of the determination, whether total uranium or uranium radioactivity, will affect the choice of method.

### 2.6.2 Feasibility and Economics

Economic factors affecting feasibility of a particular method may be classified in terms of facility cost, instrument expense, and labor cost. If a laboratory does not already have a nuclear reactor (usual cost in millions of dollars), the delayed-neutron method would not be feasible. A laser fluorometer costing over $20 000 would not be practicable for a few samples but might be if many samples are to be studied. An alpha counter or spectrometer can be obtained for under $10 000, but present radiochemical techniques are somewhat labor intensive. Method selection thus depends on such factors as existing facilities, sample load, experience of personnel, and time requirements, which must be evaluated for a given program and laboratory. An excellent example is furnished by the NURE project (Sect. 2.7), in which managers selected the most cost-effective approaches, depending on the individual laboratories' capabilities.

## 2.7 REPRESENTATIVE METHODS FOR ANALYSIS OF URANIUM

In Table 2 are summarized the methods used to determine most of the uranium concentrations tabulated in the body of this report. The concentration data are given by sources identified by references in the first column or are ascribed to one of the laboratories participating in the NURE project. References for the analytical methodology are given in the last column. The interior column headings are self-explanatory. If the authors stated precision, accuracy, and MDC values, those were used. Otherwise, these values were estimated, when possible, from representative data reported for these or similar methods or from NURE QA data, when applicable.

Table 2. Methods used to determine uranium in water samples tabulated in this report

| Source of concentration data[a] | Volume reduction[b] | Separation[b] | Measurement[b] | Estimated precision (%) | Estimated accuracy (%) | Minimum detectable concentration (μg/L) | Method[a] |
|---|---|---|---|---|---|---|---|
| [1] | E | SX, P | IDAS | 10 | | 0.01 | [1,149] |
| [4] | P | SX, IX | IDAS | | 5 | <0.1 | [4] |
| [6] | P | SX, IX | IDAS | | 5 | 0.01 | [6] |
| [9] | E | | F | | 15 | 0.1 | [146] |
| [11] | P | IX, SX | F | 15 | | <0.1 | [11] |
| [163] | | | DN | | 6 | 1 | [163] |
| [15] | E | | F | 15 | | 0.1 | [15] |
| [20] | | | F | 20 | | 5 | [137] |
| [26] | E | | F | 10 | | 0.1 | [145] |
| National Uranium Resource Evaluation Project: | | | | | | | |
| Savannah River Laboratory | IX | | DN | | <20 | 0.02 | [198] |
| Lawrence Livermore Laboratory | E | | DN | 5 | | 0.05 | [93,94,199] |
| Oak Ridge Gaseous Diffusion Plant | | SX | F | 15 | | 0.2 | [143,161,199] |
| | | SX | IDMS | 15 | | 0.02 | |
| Los Alamos Scientific Laboratory | | | F | 15 | | 0.2 | [199,205] |
| | E | | F | 20 | | 0.02 | |
| | | | DN | 4 | | 0.1 | |

[a] Numbers indicate references listed in Sect. 4.

[b] DN — activation-delayed neutron counting; E — evaporation; F — fluorometry; IDAS — isotope dilution alpha spectrometry; IX — ion exchange; P — coprecipitation; SX — solvent extraction.

# 3. URANIUM IN SURFACE, GROUND, AND DOMESTIC WATERS

## 3.1 URANIUM IN ALABAMA WATERS

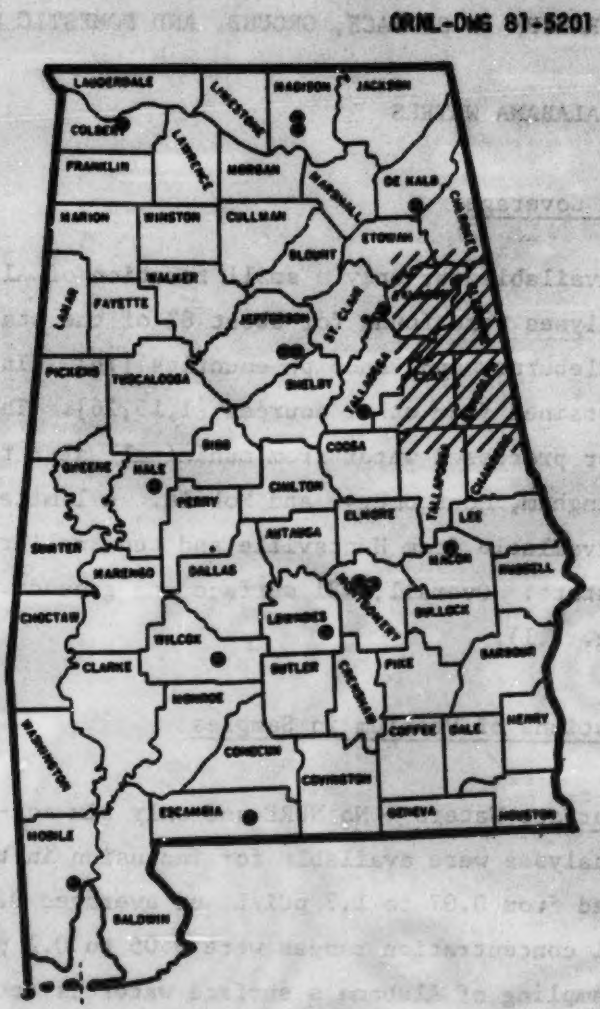
### 3.1.1 Extent of Coverage

Data were available for only a small fraction of Alabama water sites. NURE analyses were found for about 8% of the state, primarily Calhoun, Clay, Cleburne, and Randolph counties [76]. In addition, a few analyses were obtained from other sources [1,15,26]. The most important of these were for processed water from municipal water treatment plants located in Birmingham, Montgomery, and Mobile. A limited number of samples were also available from Huntsville and ten smaller towns scattered throughout the state. Overall, 421 surface and ground water sites were represented (Fig. 3.1).

### 3.1.2 Concentrations of Uranium in Samples

3.1.2.1 Surface Waters — No NURE and only six non-NURE Alabama surface water analyses were available for inclusion in this report. The latter ranged from 0.07 to 1.7 pCi/L and averaged 0.35 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.2). Although this sampling of Alabama's surface water is too meager to be statistically definitive, the observed average concentration of uranium in Alabama surface water is consistent with results obtained from a much more comprehensive sampling of Alabama ground water; consequently, there is little doubt that these surface water samples, though limited in number, indicate the correct order of magnitude of uranium in Alabama surface waters.

3.1.2.2 Ground Waters — The concentrations of uranium in Alabama's 415 ground water samples ranged from 0.01 to 2.88 pCi/L and averaged 0.05 pCi/L. The modal and median concentrations were 0.01 pCi/L (Fig. 3.3). These samples were not well distributed throughout the state, but the small range of all Alabama water samples and the strongly skewed distribution favoring low concentrations suggest that these data are representative.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LAUDERDALE
LIMESTONE
MADISON
JACKSON
COLBERT
LAWRENCE
MORGAN
FRANKLIN
MARSHALL
DE KALB
CHEROKEE
MARION
WINSTON
CULLMAN
ETOWAH
BLOUNT
LAMAR
FAYETTE
WALKER
JEFFERSON
ST. CLAIR
PICKENS
TUSCALOOSA
SHELBY
TALLADEGA
CLAY
BIBB
COOSA
GREENE
HALE
CHILTON
TALLAPOOSA
CHAMBERS
PERRY
ELMORE
LEE
SUMTER
AUTAUGA
MARENGO
DALLAS
MACON
RUSSELL
MONTGOMERY
CHOCTAW
LOWNDES
BULLOCK
WILCOX
BARBOUR
CLARKE
BUTLER
CRENSHAW
PIKE
MONROE
HENRY
WASHINGTON
CONECUH
COFFEE
DALE
COVINGTON
ESCAMBIA
GENEVA
HOUSTON
MOBILE
BALDWIN

Fig. 3.1. Locations of sample sites in Alabama.

3.1.2.3 Established Domestic and Municipal Waters — It is not known how many of the 421 Alabama water sources considered in this study actually supplied water for human consumption; however, 404 of the sites were identified as, or were presumed to be, domestic or municipal water sources. Except for Birmingham and Mobile, almost all of the sources were springs or wells. No information was available concerning the treatment, if any, that most of these waters received before consumption, but it is probable that most were used without additional processing. The concentrations of uranium in these waters ranged from 0.01 to 2.88

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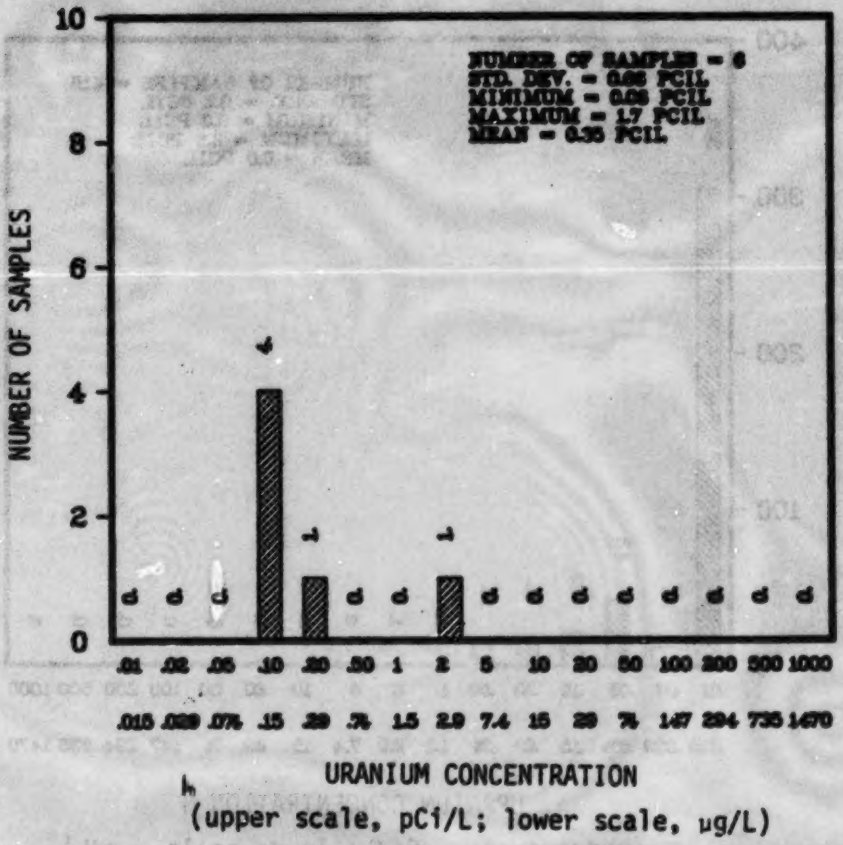

Fig. 3.2. Histogram of uranium concentrations in surface waters of Alabama.

pCi/L and averaged 0.05 pCi/L. The median and modal concentrations were 0.01 pCi/L. The frequency of occurrence of other concentration ranges is shown in Fig. 3.4.

3.1.2.4 Treated Waters from Municipal Water Purification Plants — Analyses were available for treated water from municipal water purification plants in Birmingham, Montgomery, and Mobile. Concentrations of uranium in all samples were at or near the limit of detection. Samples from the two Birmingham filter plants contained 0.1 (Shades Mountain filter plant) and <0.07 (Putnam Station filter plant) pCi/L of uranium. A sample from the Mobile treatment plant contained <0.07 pCi/L. Samples from the Court Street and Day Street treatment plants in Montgomery were

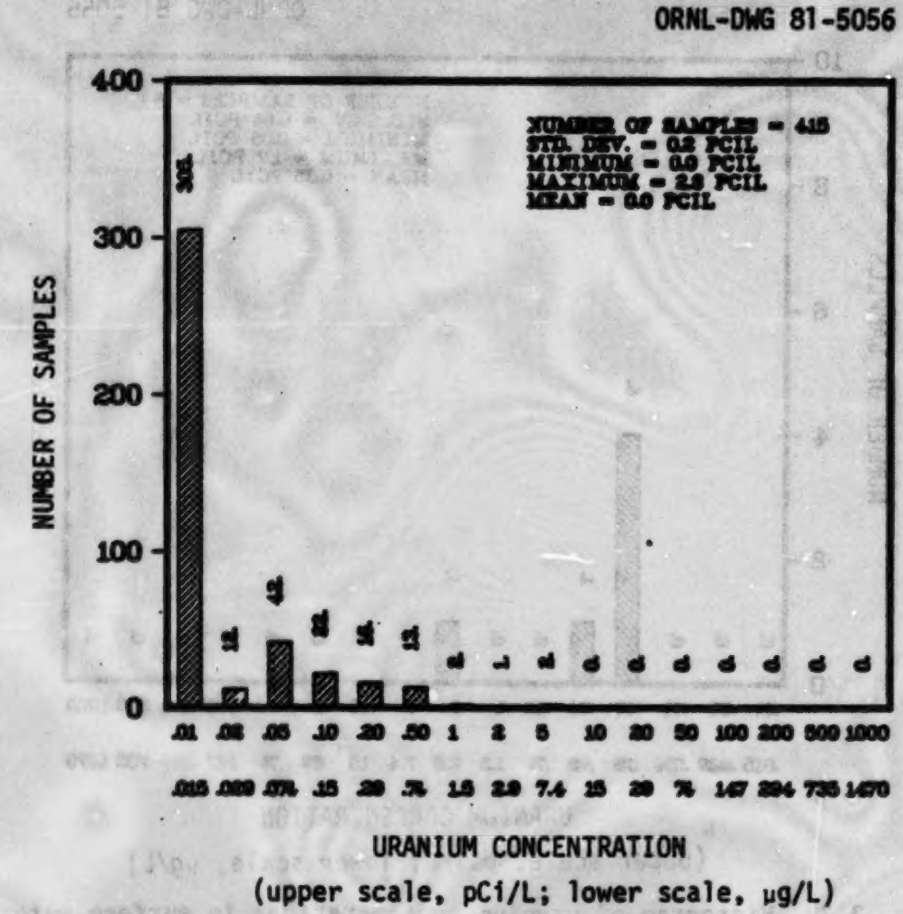

**Fig. 3.3. Histogram of uranium concentrations in ground waters of Alabama.**

**reported below the limit of detection (0.07 pCi/L). All of the above results are for samples taken in 1961 or 1962, but more recent analyses of samples composited between July and December, 1977, at Montgomery indicate that uranium in treated water from this city is at the approximate level indicated by the earlier analyses. The 1977 radioanalysis of water from Montgomery was 0.028, 0.002, and 0.014 pCi/L for $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total uranium radioactivity of this sample was 0.044 pCi/L, in good agreement with the 1961 estimate.**

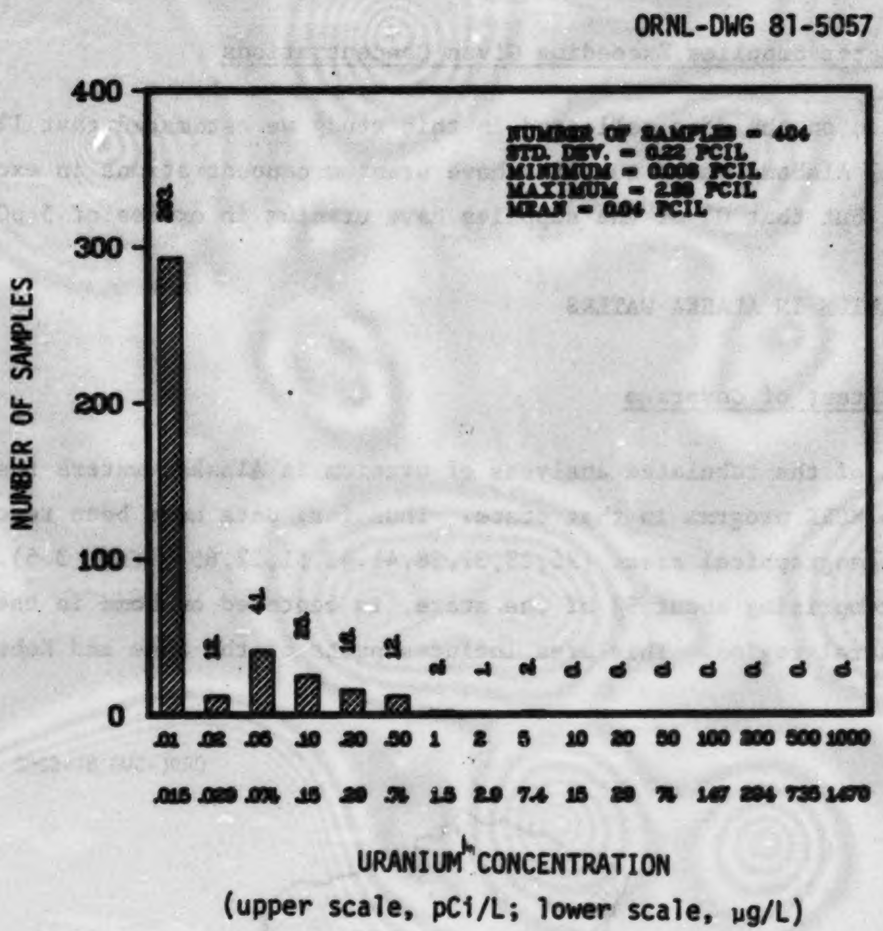

Fig. 3.4. Histogram of uranium concentrations in domestic waters of Alabama.

### 3.1.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Alabama domestic waters was estimated to be <0.1 pCi/L, 17th highest among all states (Appendix 2). This low value is consistent with the low recorded ranges of uranium in domestic, surface, and ground waters of Alabama. The alpha radiation bone dose attributable to ingestion of uranium in drinking water by Alabama residents was estimated to be 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.1.4 Water Supplies Exceeding Given Concentrations

Based on the data collected in this study we estimated that 1% to 9% of all Alabama water supplies have uranium concentrations in excess of 1 pCi/L, but that 0% of the supplies have uranium in excess of 5 pCi/L.

## 3.2 URANIUM IN ALASKA WATERS

### 3.2.1 Extent of Coverage

All of the tabulated analyses of uranium in Alaskan waters resulted from the NURE program in that state. Thus far, data have been reported for two geographical areas [26,28,37,38,41,43,51,52,65] (Fig. 3.5). The first, comprising about 9% of the state, is centered on Nome in the west-central region. This area includes parts of the Nome and Kobuk

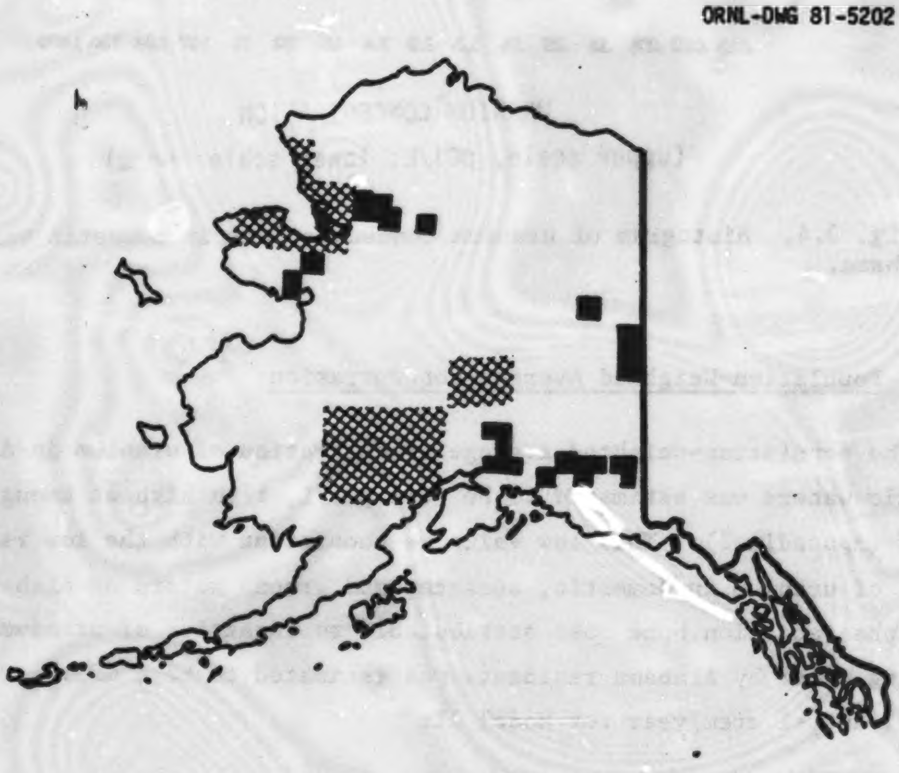

Fig. 3.5. Locations of sample sites in Alaska.

census divisions. The other well-sampled area lies in the Matanuska-Susitna and Yukon-Koyukuk census divisions between Anchorage and Fairbanks. This south-central region represents about 8% of the state's total area. In addition, a substantial number of NURE analyses were available from portions of Southeast Fairbanks, Valdez-Chitina-Whittier, and Cordova-McCarthy census divisions. Overall, 7681 water sites were sampled.

### 3.2.2 Concentrations of Uranium in Samples

3.2.2.1 Surface Waters — Analyses were available for 7681 Alaskan surface waters. Uranium concentrations in these samples ranged from 0.01 to 13.35 pCi/L and averaged 0.33 pCi/L. The median and modal concentration ranges were 0.1 to 0.2 and 0.2 to 0.5 pCi/L, respectively (Fig. 3.6).

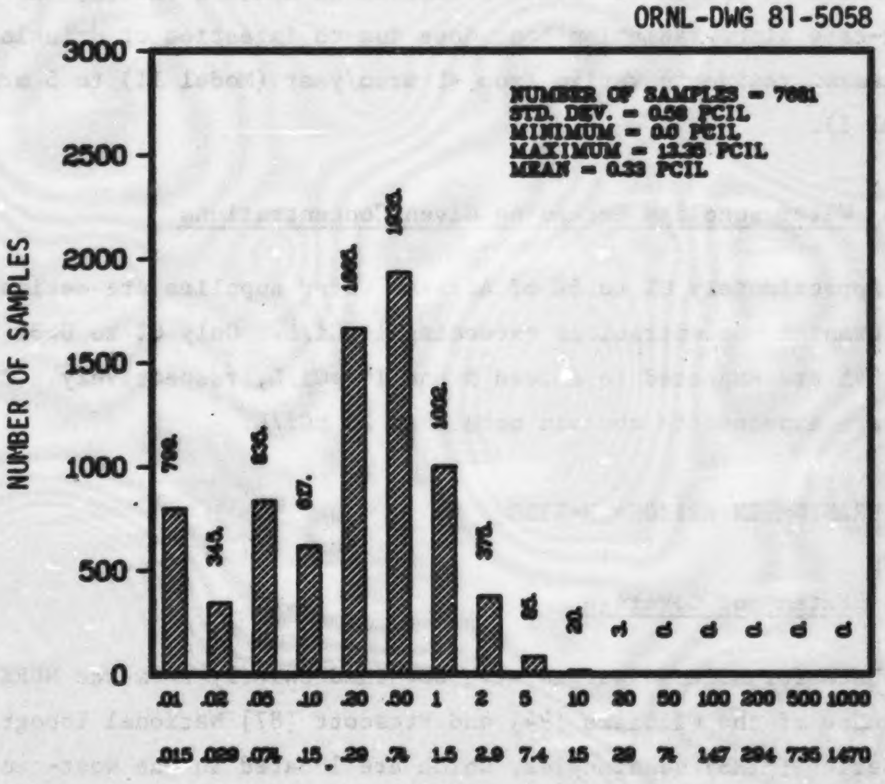

Fig. 3.6. Histogram of uranium concentrations in surface waters of Alaska.

3.2.2.2 Ground Waters -- No data were available for uranium in Alaskan ground waters.

3.2.2.3 Established Domestic and Municipal Waters — No data were found for Alaskan waters identified as domestic or municipal.

3.2.2.4 Treated Waters from Municipal Water Purification Plants — No data were available for treated waters from municipal water purification plants.

### 3.2.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Alaskan waters was estimated to be 0.3 pCi/L, 14th highest among the states. This value was derived from surface water analyses (Appendix 2) rather than from domestic water data since no analyses of the latter type were available for Alaskan waters.

Based on the above value of uranium in Alaskan waters, the estimated worst-case alpha radiation bone dose due to ingestion of drinking water by Alaskan residents varied from <1 mrem/year (Model II) to 5 mrem/year (Model I).

### 3.2.4 Water Supplies Exceeding Given Concentrations

Approximately 0% to 6% of Alaskan water supplies are estimated to have uranium concentrations exceeding 1 pCi/L. Only 0% to 0.3% and 0% to 0.04% are expected to exceed 5 and 10 pCi/L, respectively. Zero percent are expected to contain more than 20 pCi/L.

## 3.3 URANIUM IN ARIZONA WATERS

### 3.3.1 Extent of Coverage

Data for Arizona waters were obtained chiefly from the NURE reconnaissance of the Williams [94] and Prescott [87] National Topographical Map Series (NTMS) quadrangles, which are located in the west-central region of the state and correspond to parts of Mohave, Coconino, Yuma, and Yavapai counties. Data for a few Arizona sample sites were also obtained from the NURE reconnaissance of the Kingman [89] and Las Vegas [90] NTMS quadrangles. About one-sixth of the state's area was systematically covered in these surveys (Fig. 3.7). Other data include analyses of samples from 12 locations on the Navajo Indian Reservation [3], the Rio Puerco [5], 20 selected sites throughout the state [15], and several Arizona mineral springs [17]. Overall, 604 surface and ground water sites were sampled.

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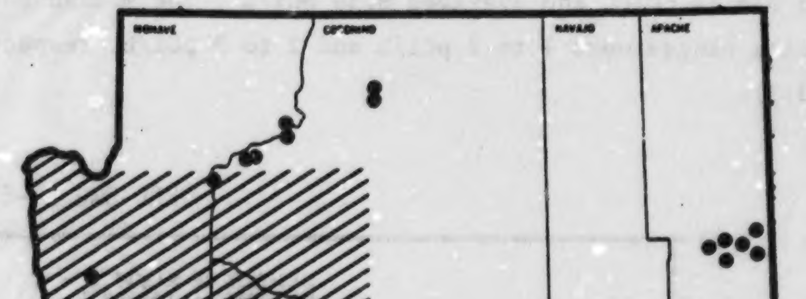
MOHAVE
COCONINO
NAVAJO
APACHE
YAVAPAI
GILA
YUMA
MARICOPA
PINAL
GRAHAM
GREENLEE
PIMA
COCHISE
SANTA CRUZ

Fig. 3.7. Locations of sample sites in Arizona.

### 3.3.2 Concentrations of Uranium in Samples

3.3.2.1 Surface Waters — Arizona has relatively few surface water sites, and only 21 of the 604 recorded Arizona samples were obtained from such sources. The uranium content of these samples ranged from 0.05 to 4.69 pCi/L and averaged 1.41 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L (Fig. 3.8).

3.3.2.2 Ground Waters — Analyses were found for 583 Arizona ground water samples. The uranium concentrations in these samples ranged from 0.01 to 338.84 pCi/L and averaged 8.59 pCi/L. The median and modal concentration ranges were 1 to 2 pCi/L and 2 to 5 pCi/L, respectively (Fig. 3.9).

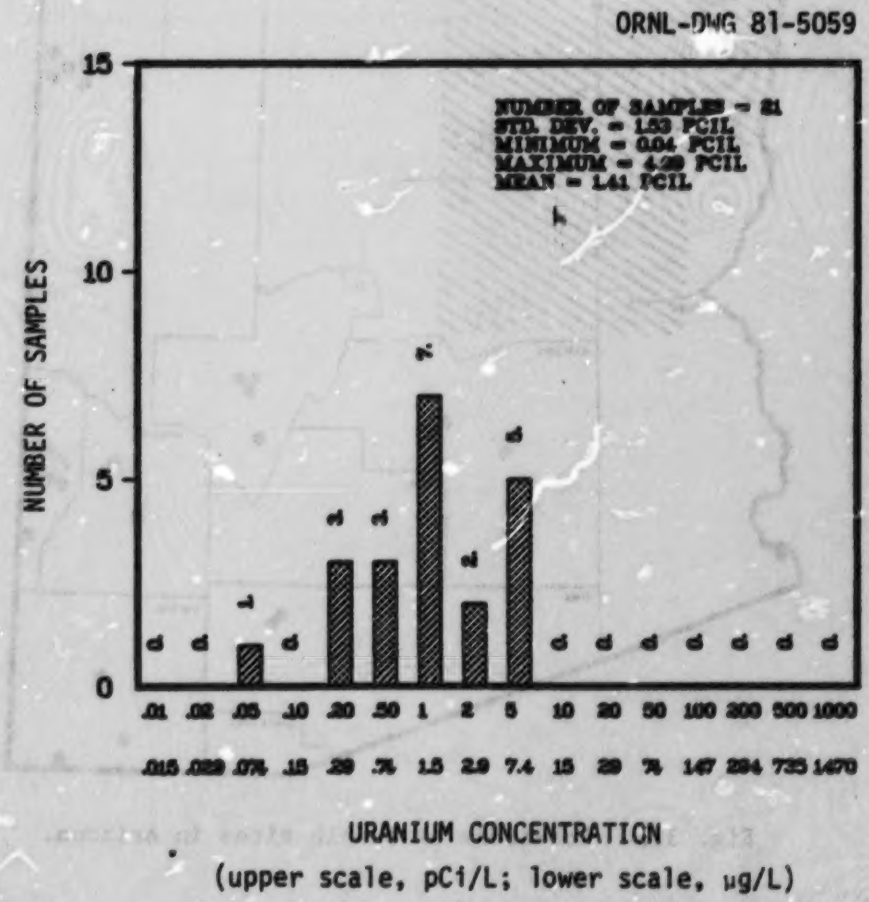

Fig. 3.8. Histogram of uranium concentrations in surface waters of Arizona.

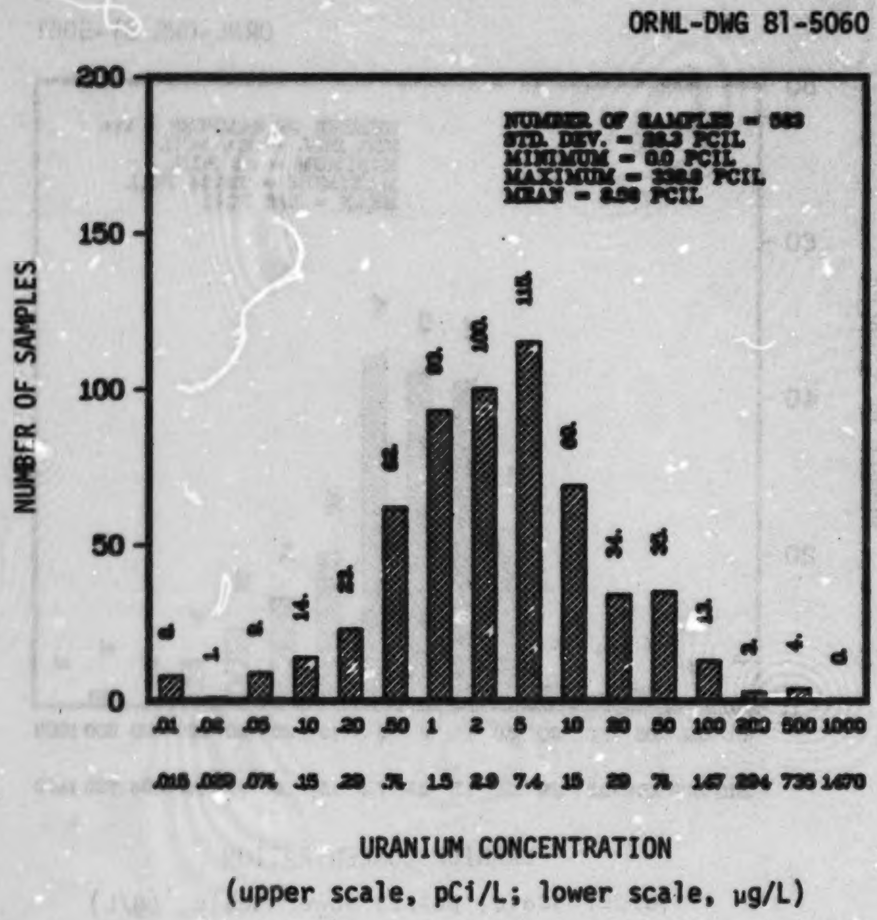

Fig. 3.9. Histogram of uranium concentrations in ground waters of Arizona.

3.3.2.3 Established Domestic and Municipal Waters — Approximately 35% of the Arizona sample sites (214) were identified as domestic water sources. The concentrations of uranium in these samples ranged from 0.01 to 339 pCi/L and averaged 8.65 pCi/L. The median and modal concentration ranges were 1 to 2 pCi/L and 2 to 5 pCi/L, respectively. The frequency of occurrence of other concentration ranges is shown in Fig. 3.10.

3.3.2.4 Treated Waters from Municipal Water Purification Plants — Analyses of samples taken in 1962 were available for treated water from four Phoenix and three Tucson water treatment facilities. For treatment

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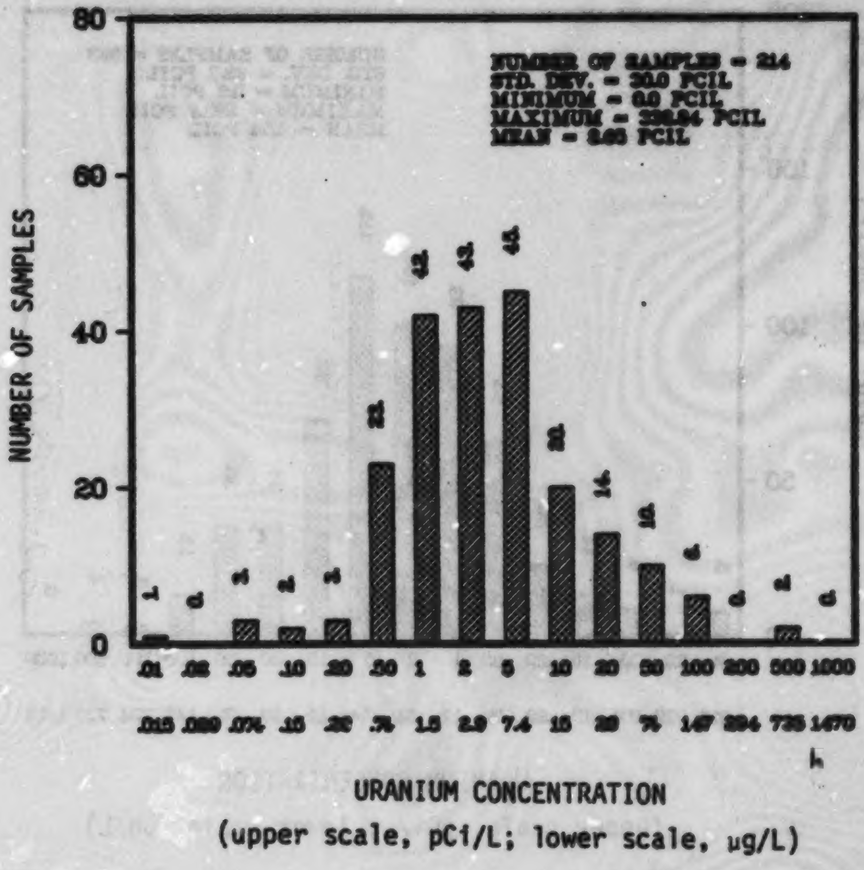

Fig. 3.10. Histogram of uranium concentrations in domestic waters of Arizona.

plants in Phoenix these values were 0.95 (Verde River), 0.88 (Squaw Peak), 1.77 (Verde Well Field), and 3.74 (Scottsdale Well No. 36) pCi/L uranium. The analyses for water from treatment plants in Tucson were slightly higher: 4.22 (South-side Wells), 1.09 (North-side Wells), and 4.96 (Upper Santa Cruz Wells) pCi/L uranium.

### 3.3.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Arizona domestic waters was estimated to be 2.5 pCi/L (Appendix 2). This concentration ranks 6th highest among all states. Based on this average concentration, the estimated worst-case alpha radiation bone dose was 37 mrem/year for Model I and 1 mrem/year for Model II.

### 3.3.4 Water Supplies Exceeding Given Concentrations

Using previously described procedures we estimated that 65% to 70% of Arizona's domestic water supplies contained uranium in excess of 1 pCi/L; 0% to 24%, in excess of 5 pCi/L; 0% to 15%, in excess of 10 pCi/L; and 0% to 8%, in excess of 20 pCi/L.

## 3.4 URANIUM IN ARKANSAS WATERS

### 3.4.1 Extent of Coverage

Uranium analyses were available for only a small fraction, about 8%, of the waters of Arkansas. Most of Fulton, Izard, Sharp, Lawrence, and Green counties and all of Randolph and Clay counties were sampled systematically during the NURE reconnaissance of the Poplar Bluff NTMS quadrangle [80]. In addition, Scott and Barker [15] sampled selected wells and springs in Cave City, Lepanto, Norman, Pine Bluff, and Murfreesboro. Overall, 264 surface and ground water sites were surveyed (Fig. 3.11).

### 3.4.2 Concentrations of Uranium in Samples

3.4.2.1 Surface Waters — Almost all of the recorded Arkansas samples were surface water (259) in which uranium concentrations ranged from 0.01 to 1.77 pCi/L and averaged 0.15 pCi/L. The median and modal concentration ranges were 0.1 to 0.2 pCi/L (Fig. 3.12).

3.4.2.2 Ground Waters — Only five Arkansas ground water analyses were available. The range for this small sample set was 0.07 to 0.20 pCi/L. The mean was 0.10 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.13). Although this sample set is limited in size, the range, mean, and mode are consistent with similar data from the larger surface water subset and are reasonable.

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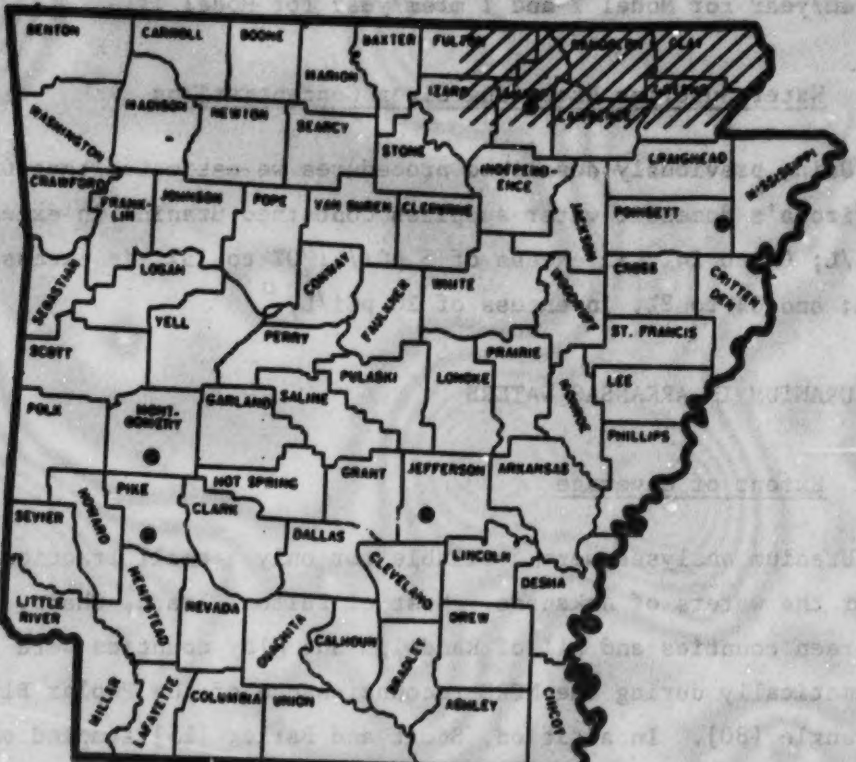
BENTON
CARROLL
BOONE
BAXTER
FULTON
RANDOLPH
CLAY
MARION
IZARD
SHARP
LAWRENCE
GREENE
MADISON
NEWTON
SEARCY
WASHINGTON
STONE
INDEPENDENCE
CRAIGHEAD
MISSISSIPPI
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
JACKSON
POINSETT
SEBASTIAN
LOGAN
CONWAY
WHITE
CROSS
CRITTENDEN
YELL
FAULKNER
WOODRUFF
ST. FRANCIS
SCOTT
PERRY
PRAIRIE
PULASKI
LONOKE
LEE
POLK
MONTGOMERY
GARLAND
SALINE
MONROE
PHILLIPS
HOT SPRING
GRANT
JEFFERSON
ARKANSAS
SEVIER
HOWARD
PIKE
CLARK
DALLAS
LINCOLN
CLEVELAND
DESHA
LITTLE RIVER
HEMPSTEAD
NEVADA
OUACHITA
CALHOUN
DREW
BRADLEY
MILLER
LAFAYETTE
COLUMBIA
UNION
ASHLEY
CHICOT

Fig. 3.11. Locations of sample sites in Arkansas.

**3.4.2.3 Established Domestic and Municipal Waters** — Only 5 of the 264 Arkansas sample sites were identified as domestic water sources. The concentrations of uranium in these samples ranged from 0.06 to 0.20 pCi/L and averaged 0.09 pCi/L. The most frequently occurring concentration range was 0.05 to 0.1 pCi/L (Fig. 3.14).

**3.4.2.4 Treated Waters from Municipal Water Purification Plants** — No uranium analyses were available for treated waters from municipal water purification plants in Arkansas.

### 3.4.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Arkansas waters was estimated to be <0.1, 17th highest among all states (Appendix 2). The corresponding alpha radiation bone dose estimates were 1 mrem/year for Model 1 and <1 mrem/year for Model II.

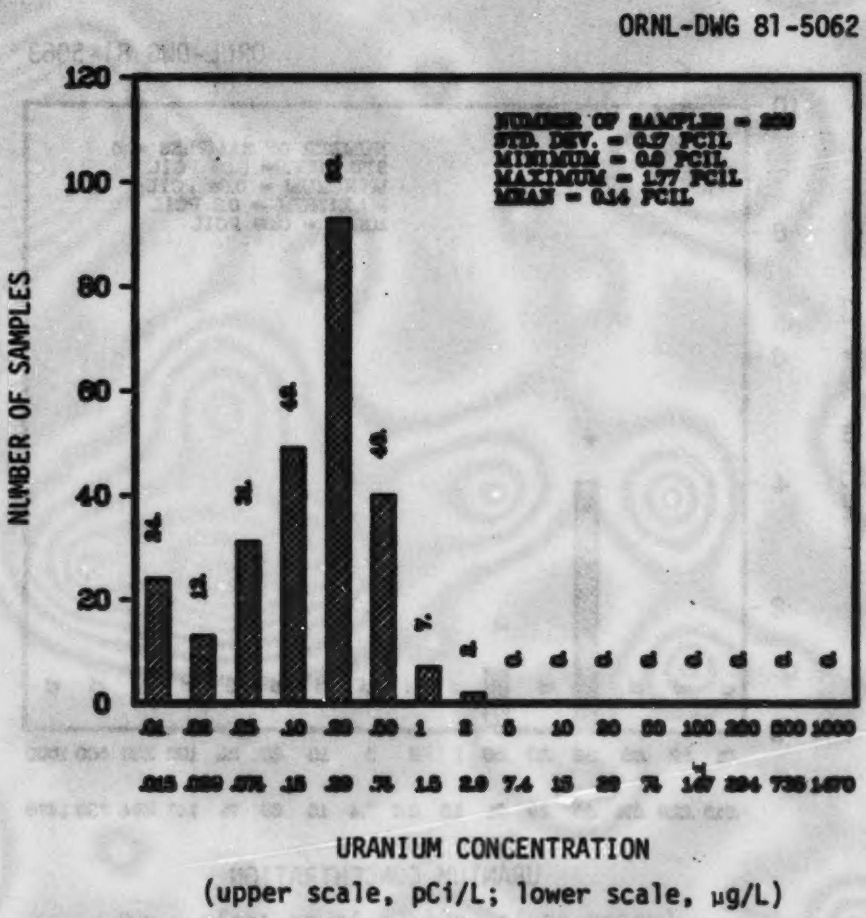

Fig. 3.12. Histogram of uranium concentrations in surface waters of Arkansas.

### 3.4.4 Water Supplies Exceeding Given Concentrations

Based on limited data, we estimated that 0% of Arkansas water supplies contain uranium in excess of 1 pCi/L (Appendix 2).

## 3.5 URANIUM IN CALIFORNIA WATERS

### 3.5.1 Extent of Coverage

NURE analyses [89,90] were available for less than 5% of California's surface, specifically, portions of San Bernardino, Alpine, Tuolumne, and Mono counties (Fig. 3.15). However, U.S. Geological Survey [26] or EPA

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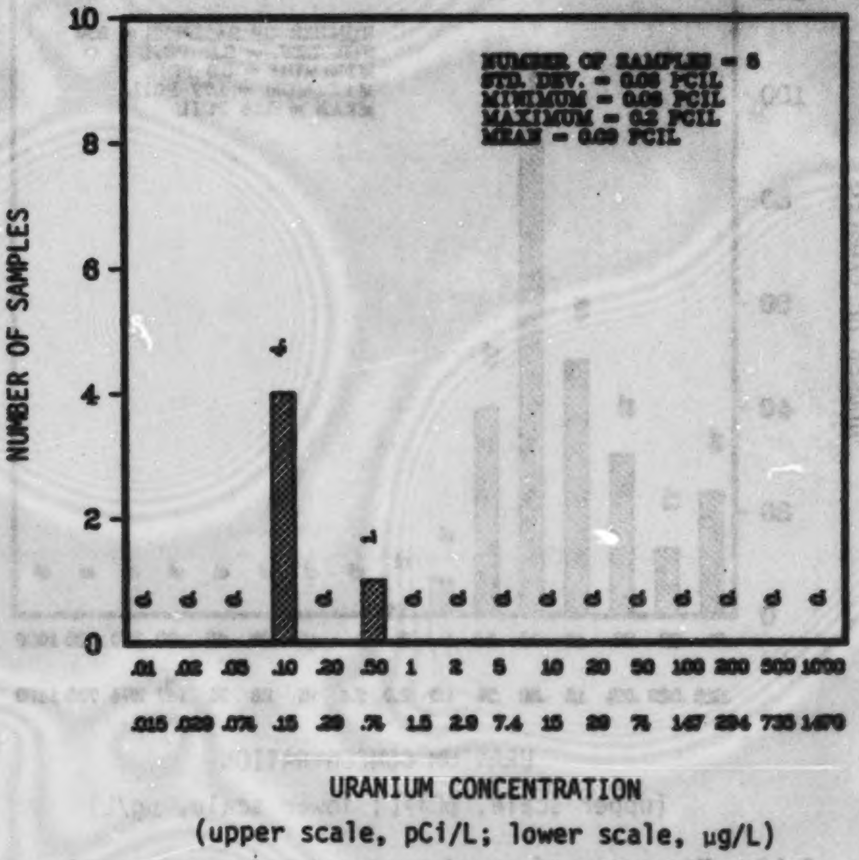

Fig. 3.13. Histogram of uranium concentrations in ground waters of Arkansas.

[1] analyses were found for treated water from Berkeley, Fresno, Long Beach, Los Angeles, Oakland, Sacramento, San Diego, San Francisco, and San Jose. In addition, other U.S. Geological Survey data [15] were available for Bridgeport, Winters, Sacramento, Long Beach, and Redlands. Overall, 46 surface and ground water sites were surveyed.

### 3.5.2 Concentrations of Uranium in Samples

3.5.2.1 Surface Waters — Of the 46 California sources sampled, 7 were surface water. The concentrations of uranium in these samples

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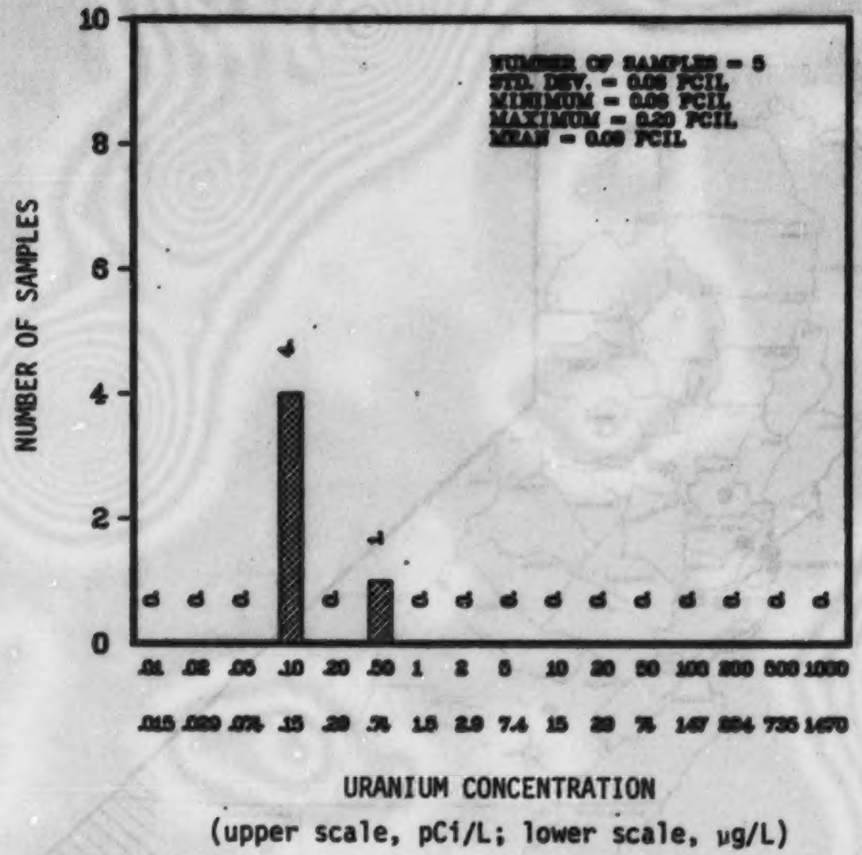

Fig. 3.14. Histogram of uranium concentrations in domestic waters of Arkansas.

ranged from 0.07 to 5.84 pCi/L and averaged 2.04 pCi/L. The modal concentration ranges were 0.05 to 0.10 pCi/L and 2 to 5 pCi/L. The median concentration range was 0.2 to 0.5 pCi/L (Fig. 3.16).

3.5.2.2 Ground Waters — Analyses were available for 39 California ground water samples. Uranium in these samples varied from 0.07 to 448.80 pCi/L and averaged 18.00 pCi/L. The high value of the average is due to the effect of a single sample and is somewhat misleading. If the single high-valued sample is omitted, the resulting California ground water mean would be 6.69 pCi/L. The median and mode are more representative indicators of uranium concentrations in California ground waters. The median concentration range was 2 to 5 pCi/L. The modal concentration range was 1 to 2 pCi/L (Fig. 3.17).

ORNL-DWG 81-5205

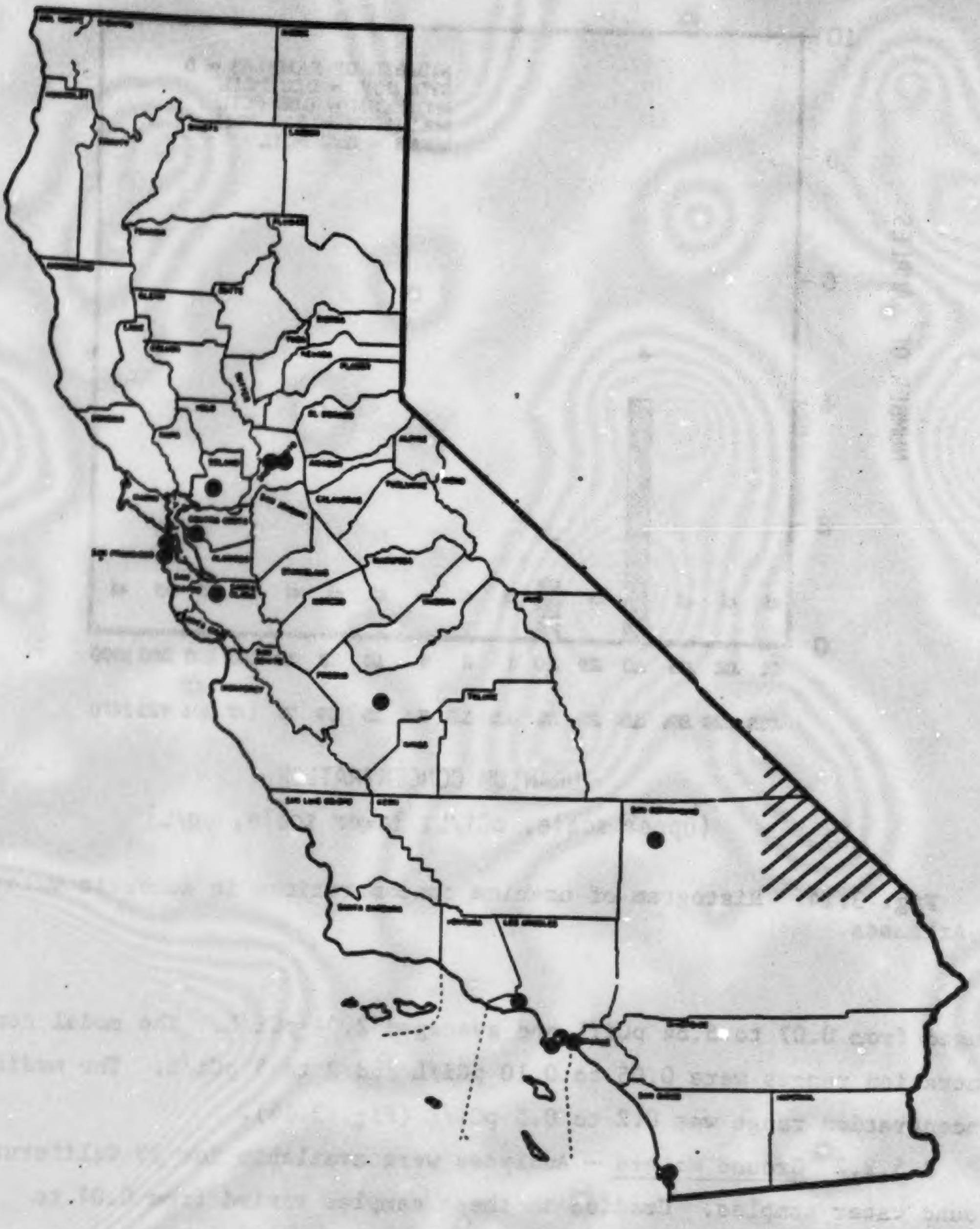

Fig. 3.15. Locations of sample sites in California.

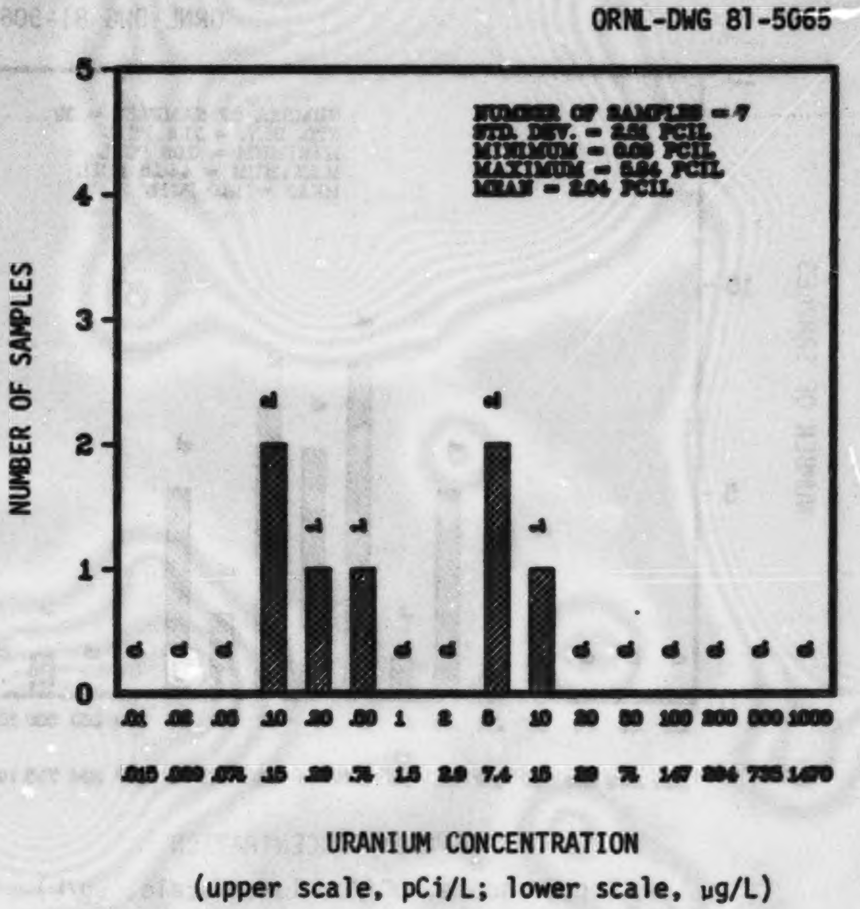

**Fig. 3.16. Histogram of uranium concentrations in surface waters of California.**

**3.5.2.3 Established Domestic and Municipal Waters — Twenty-five of the California water sites were established as domestic water sources. The concentrations of uranium in these samples ranged from 0.06 to 449 pCi/L and averaged 20.42 pCi/L. As mentioned above, the high value of the mean is due to a single high-valued sample; if it is excluded, the revised mean would be 2.58 pCi/L. The most frequently occurring concentration range among California domestic water sources was 2 to 5 pCi/L (Fig. 3.18).**

**3.5.2.4 Treated Waters from Municipal Water Purification Plants — The concentrations of uranium in water from California municipal water treatment plants varied from the limit of detection to about 6 pCi/L.**

ORNL-DWG 81-5066

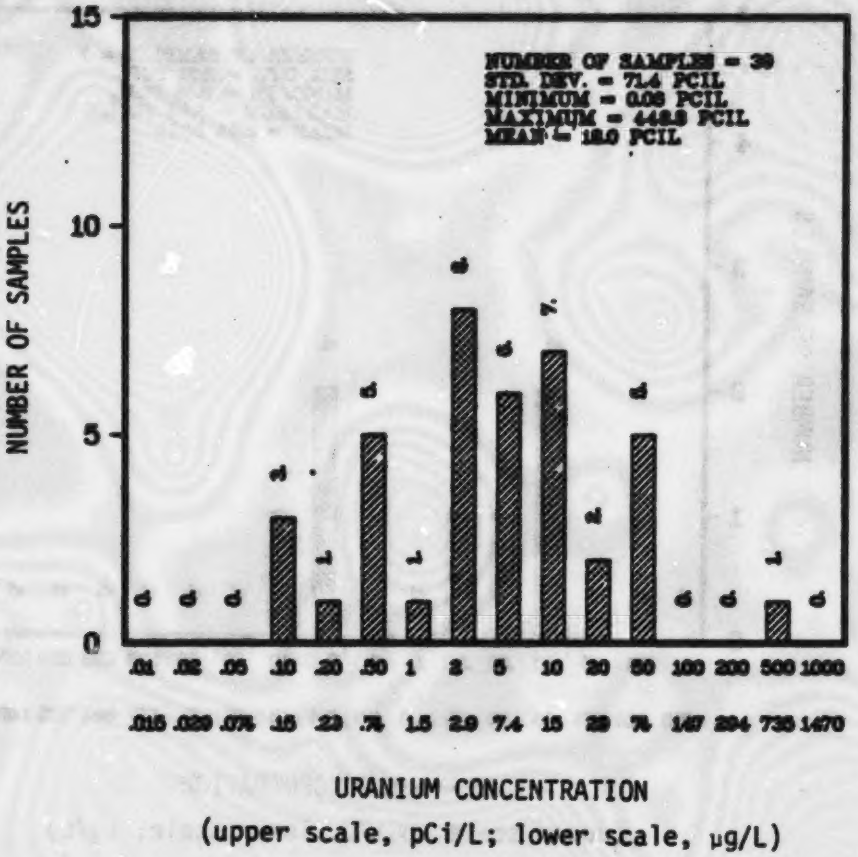

Fig. 3.17. Histogram of uranium concentrations in ground waters of California.

Analyses of samples collected in 1961 and 1962 show that uranium in treated waters from Oakland and Sacramento was below the limit of detection, 0.07 pCi/L. The concentrations (in pCi/L) of uranium in treated water from other cities were as follows: Fresno, 0.34; Long Beach, <0.10, 5.85; Los Angeles, 3.26; San Diego, 4.69; San Francisco, 0.14, 0.20; and San Jose, 0.34. Although nearly 19 years old, the above analyses still appear to be good indicators of current uranium levels. For example, a July to December, 1977, composite of water from the Los Angeles system contained 1.470, 0.063, and 1.400 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$ [1]. These isotopic uranium concentrations total 2.933 pCi/L, in good agreement with the 1962 value from Los Angeles.

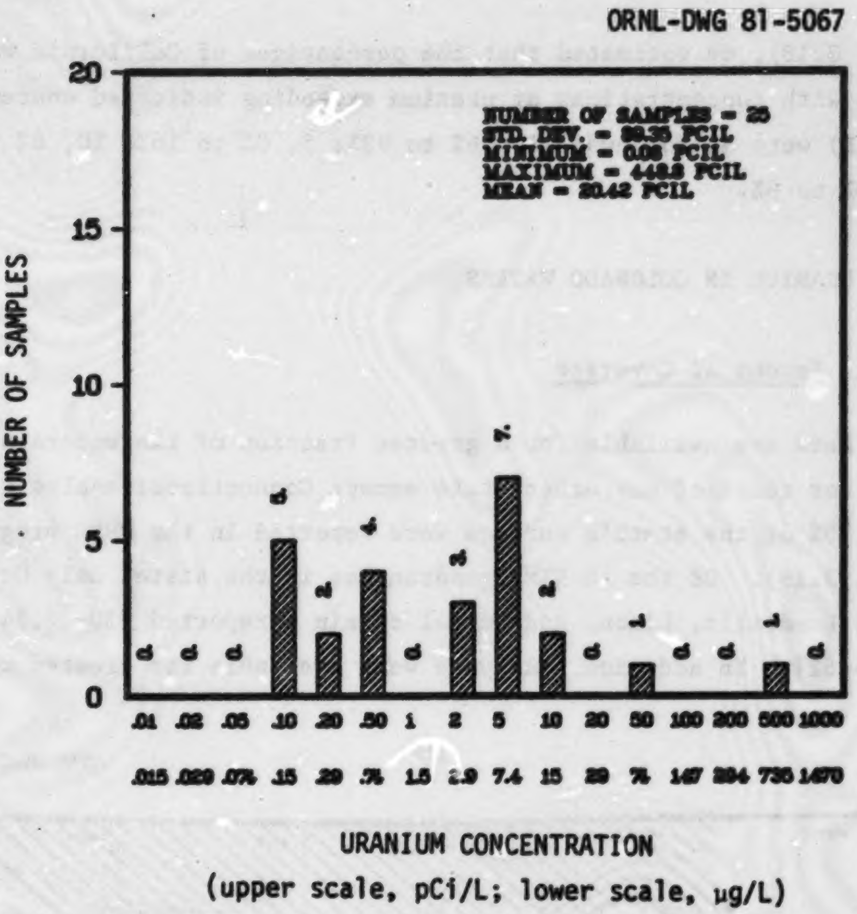

Fig. 3.18. Histogram of uranium concentrations in domestic waters of California.

### 3.5.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in California domestic waters was estimated as 2.7 pCi/L (Appendix 2). This concentration ranks 4th highest among all states. The corresponding alpha radiation bone dose estimates were 41 mrem/year for Model I and 2 mrem/year for Model II.

### 3.5.4 Water Supplies Exceeding Given Concentrations

Based on measured and estimated concentrations of uranium in water from municipal water treatment plants (Appendix 2) and from data presented in the histogram of uranium concentrations in domestic waters

(Fig. 3.18), we estimated that the percentages of California water supplies with concentrations of uranium exceeding indicated concentrations (pCi/L) were as follows: 1, 56% to 93%; 5, 0% to 16%; 10, 0% to 8%; 20, 0% to 8%.

## 3.6 URANIUM IN COLORADO WATERS

### 3.6.1 Extent of Coverage

Data are available for a greater fraction of the waters of Colorado than for those of any other state except Connecticut; analyses for water from 75% of the state's surface were reported in the NURE program (Fig. 3.19). Of the 16 NTMS quadrangles in the state, only Grand Junction, Leadville, Limon, and Vernal remain unreported [30-32,34,39,40,44,48,54,62]. In addition, analyses were available for treated water from

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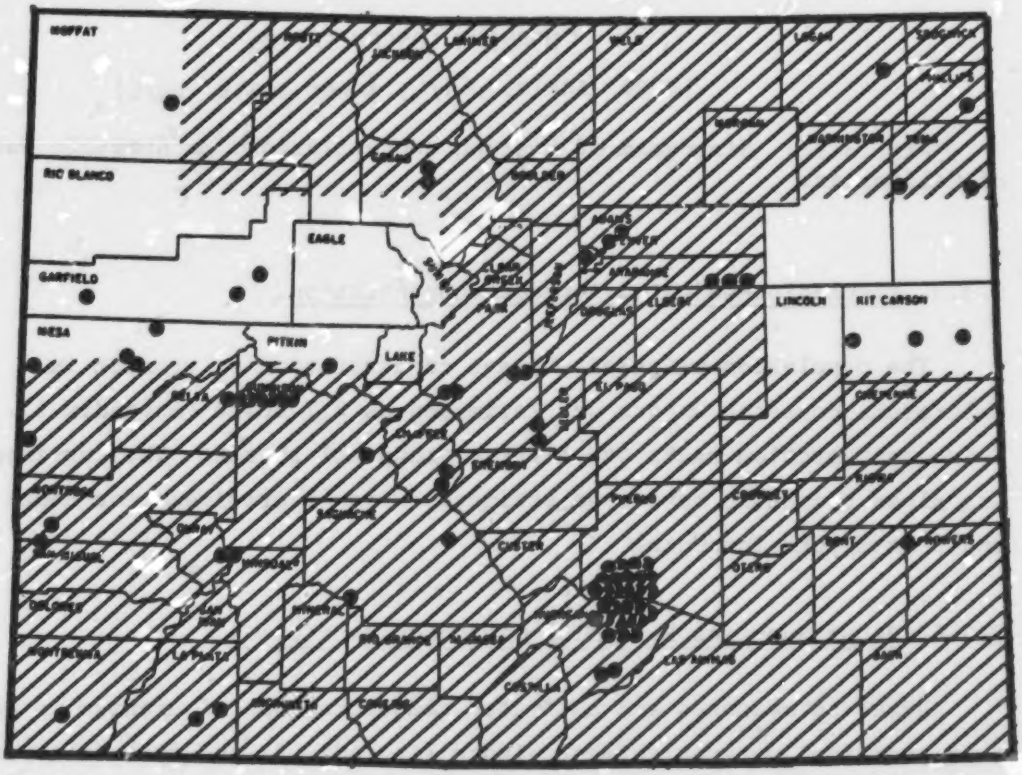
MOFFAT
ROUTT
JACKSON
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
MORGAN
WASHINGTON
YUMA
RIO BLANCO
GRAND
BOULDER
ADAMS
DENVER
EAGLE
SUMMIT
CLEAR CREEK
ARAPAHOE
GARFIELD
JEFFERSON
PARK
DOUGLAS
ELBERT
LINCOLN
KIT CARSON
MESA
PITKIN
LAKE
DELTA
GUNNISON
TELLER
EL PASO
CHEYENNE
CHAFFEE
FREMONT
MONTROSE
KIOWA
PUEBLO
CROWLEY
OURAY
SAGUACHE
CUSTER
SAN MIGUEL
HINSDALE
BENT
PROWERS
OTERO
DOLORES
SAN JUAN
MINERAL
HUERFANO
MONTEZUMA
LA PLATA
RIO GRANDE
ALAMOSA
LAS ANIMAS
BACA
COSTILLA
ARCHULETA
CONEJOS

Fig. 3.19. Locations of sample sites in Colorado.

three Denver municipal water treatment plants [1,26] and for water from 83 other selected sites [12,14-17]. Overall, 13 553 surface and ground water sites were surveyed.

### 3.6.2 Concentrations of Uranium in Samples

3.6.2.1 Surface Waters — Numerous data were available for Colorado surface water sources; 6225 analyses were recorded. Uranium concentrations ranged from 0.01 to 582.38 pCi/L, with a mean of 2.43 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.20).

3.6.2.2 Ground Waters — Colorado ground water sites were also well represented; analyses were available for 7328 locations. Uranium concentrations in these samples ranged from 0.01 to 508.9 pCi/L, averaging

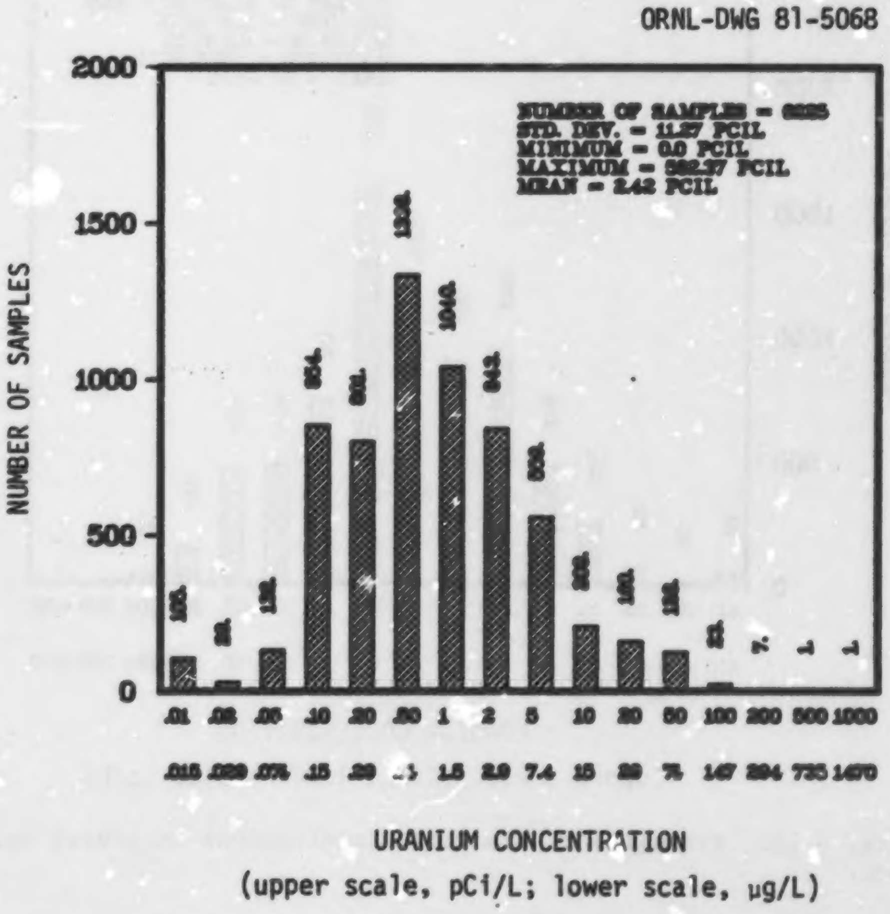

Fig. 3.20. Histogram of uranium concentrations in surface waters of Colorado.

6.77 pCi/L. The median and modal concentration ranges were 1 to 2 pCi/L, and 2 to 5 pCi/L, respectively (Fig. 3.21).

3.6.2.3 Established Domestic and Municipal Waters — Only 199 of the surface and ground water sites were identified as domestic water sources. Among these samples the concentrations of uranium ranged from 0.01 to 122 pCi/L, averaging 5.02 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L and 1 to 2 pCi/L, respectively (Fig. 3.22).

3.6.2.4 Treated Waters from Municipal Water Purification Plants — In 1961 the concentrations of uranium in treated waters from the three Denver municipal treatment plants were as follows: Moffat filter plant, 0.14 pCi/L; Marston Lake North-side filter plant, 1.16 pCi/L; and Kassler

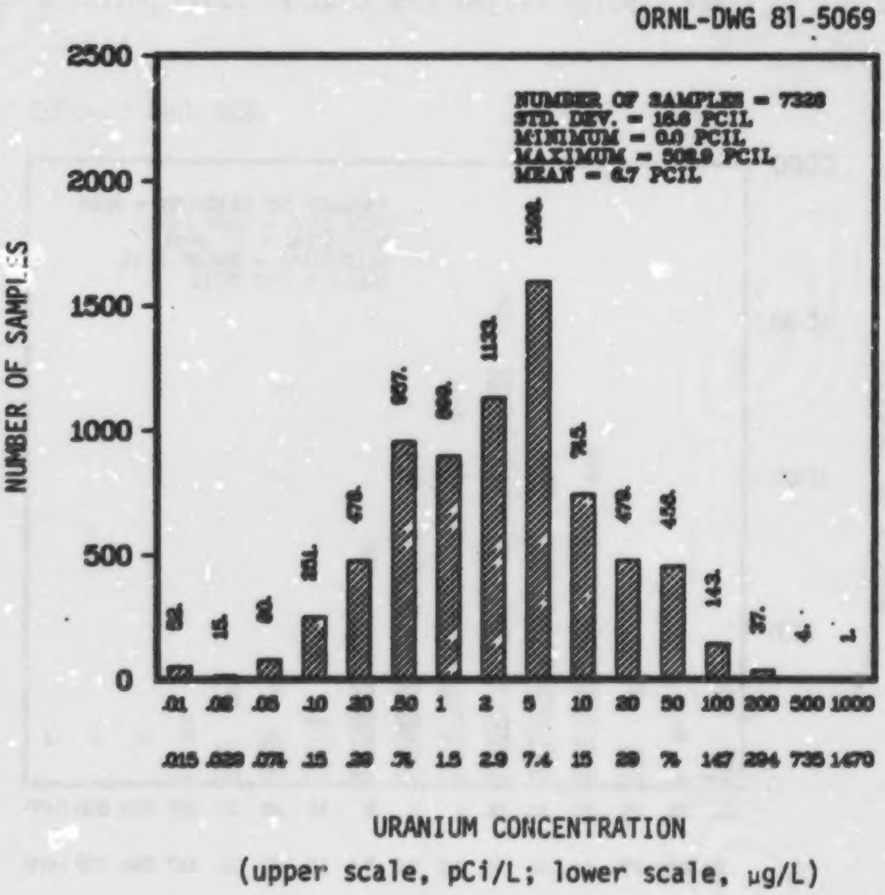

Fig. 3.21. Histogram of uranium concentrations in ground waters of Colorado.

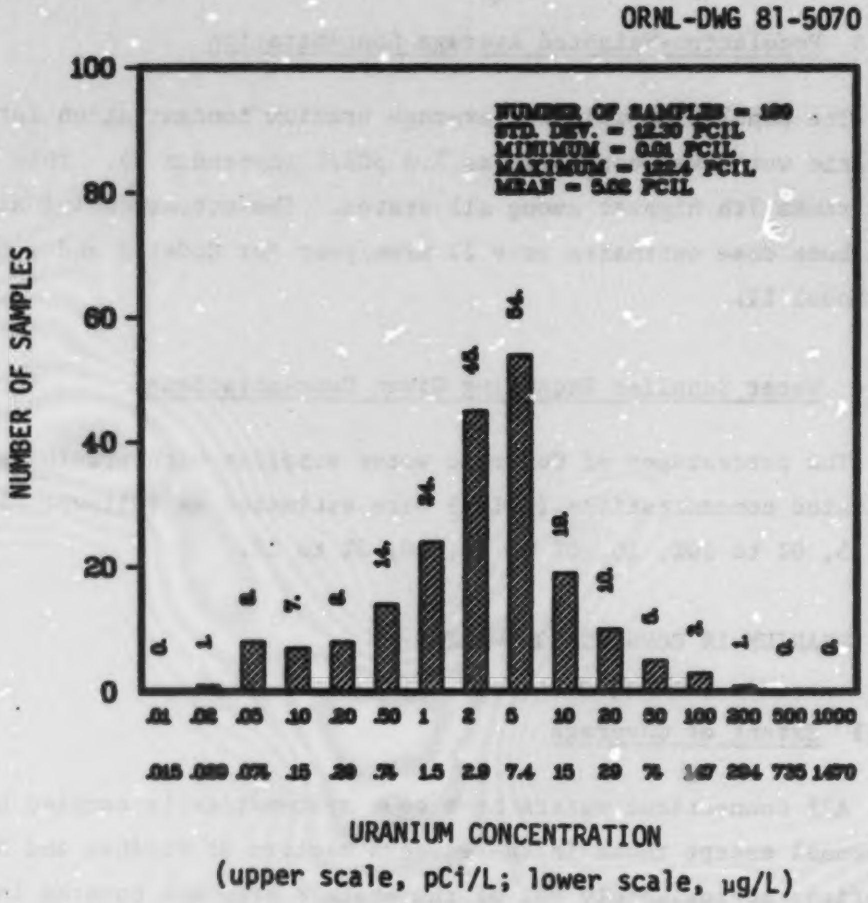

**Fig. 3.22. Histogram of uranium concentrations in domestic waters of Colorado.**

**filter plant, 1.90 pCi/L. The volume-weighted average for the Denver system was 0.75 pCi/L. A more recent treated water sample from the Denver system, composited between July and December, 1977, contained 1.21, 0.096, and 0.974 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total uranium activity of this sample was 2.28 pCi/L [1]. A similar value, 1.75 pCi/L, was obtained for another sample composited between July 1976 and June 1977 [201].**

### 3.6.3 Population-Weighted Average Concentration

The population-weighted average uranium concentration for Colorado domestic water was estimated as 1.8 pCi/L (Appendix 2). This concentration ranks 7th highest among all states. The corresponding alpha radiation bone dose estimates were 27 mrem/year for Model I and 1 mrem/year for Model II.

### 3.6.4 Water Supplies Exceeding Given Concentrations

The percentages of Colorado water supplies with uranium exceeding indicated concentrations (pCi/L) were estimated as follows: 1, 6% to 46%; 5, 0% to 10%; 10, 0% to 5%; 20, 0% to 2%.

## 3.7 URANIUM IN CONNECTICUT WATERS

### 3.7.1 Extent of Coverage

All Connecticut waters have been systematically sampled by NURE personnel except those in the eastern sectors of Windham and New London counties; approximately 90% of the state's area was covered in this survey [81,82]. In addition, non-NURE analyses were available for treated waters from Bridgeport, Hartford, and New Haven water purification plants, and for selected samples in Plainville and Willimantic [15,26] (Fig. 3.23). Overall, 1358 surface and ground water sites were sampled.

### 3.7.2 Concentrations of Uranium in Samples

3.7.2.1 Surface Waters — The concentrations of uranium in 608 Connecticut surface water samples ranged from 0.01 to 7.51 pCi/L and averaged 0.08 pCi/L. The median and mode were 0.01 pCi/L (Fig. 3.24).

3.7.2.2 Ground Waters — Analyses were found for 750 Connecticut ground water sources. The concentrations of uranium in water from these sources ranged from 0.01 to 26.75 pCi/L and averaged 0.74 pCi/L. The median and modal concentration ranges were 0.1 to 0.2 pCi/L and 0.02 to 0.05 pCi/L, respectively (Fig. 3.25).

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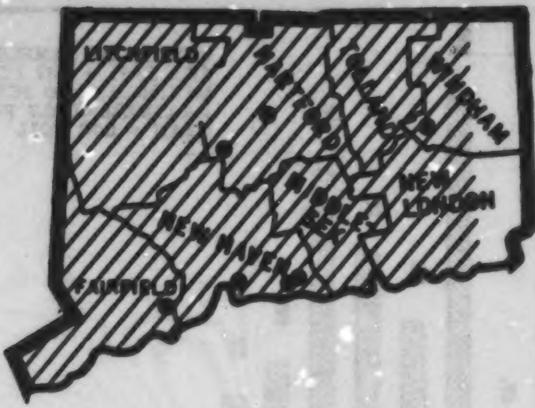
LITCHFIELD
HARTFORD
TOLLAND
WINDHAM
NEW LONDON
MIDDLESEX
NEW HAVEN
FAIRFIELD

Fig. 3.23. Locations of sample sites in Connecticut.

ORNL-DWG 81-5071

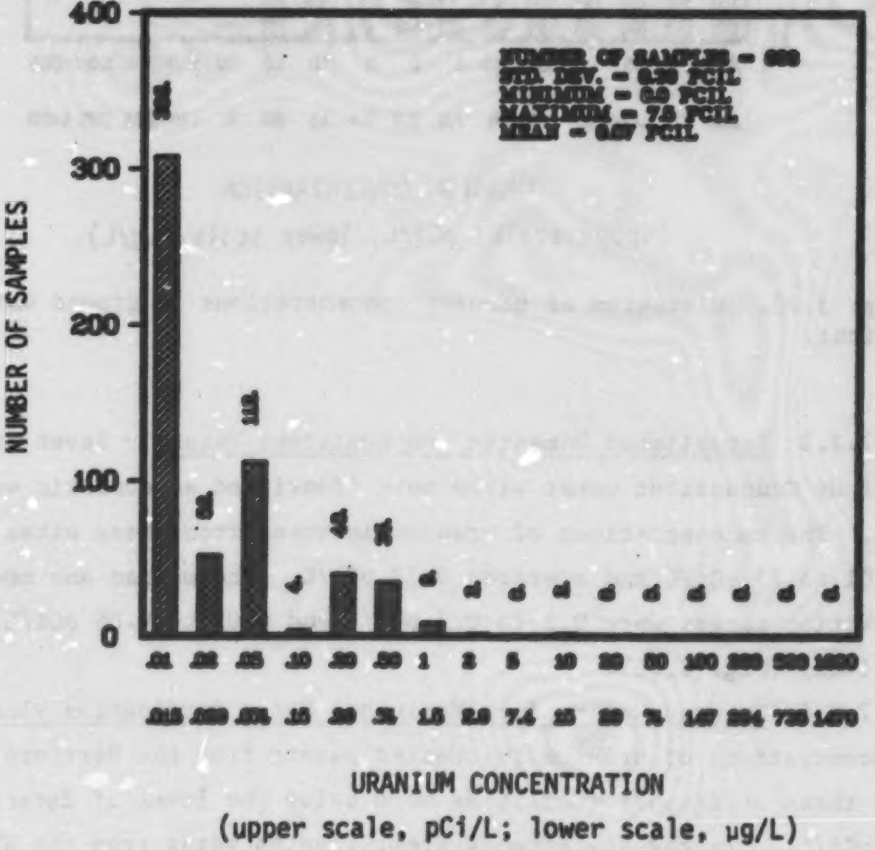

Fig. 3.24. Histogram of uranium concentrations in surface waters of Connecticut.

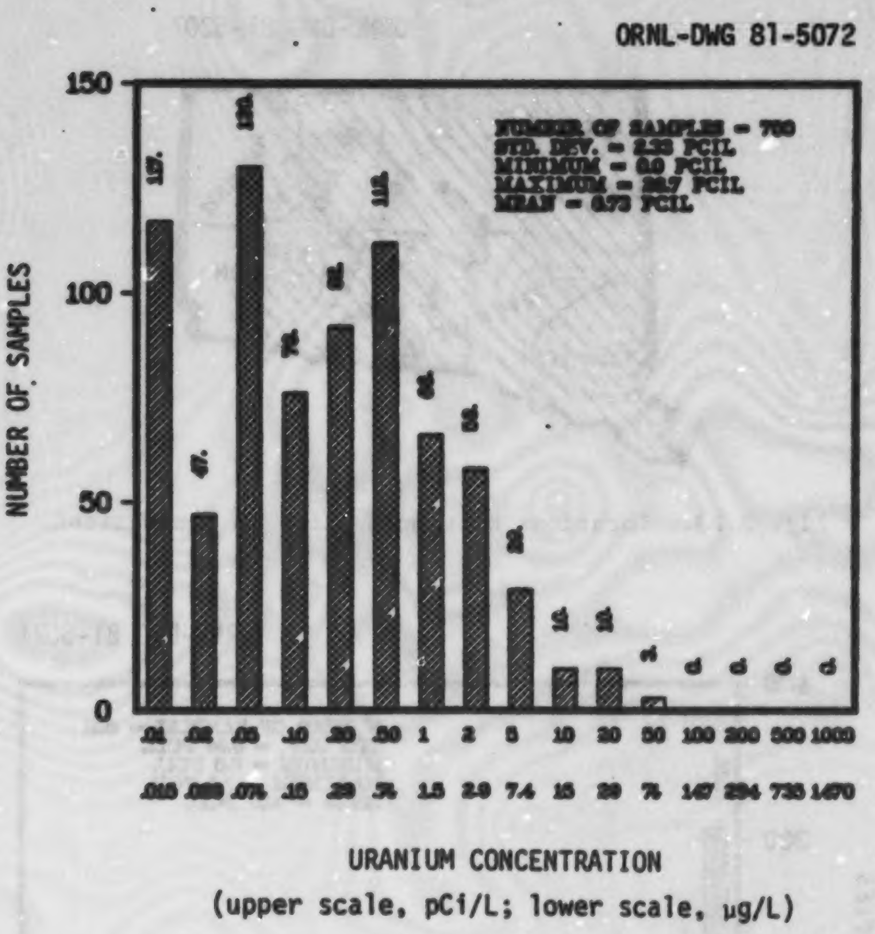

Fig. 3.25. Histogram of uranium concentrations in ground waters of Connecticut.

3.7.2.3 Established Domestic and Municipal Waters — Seven hundred thirty-four Connecticut water sites were identified as domestic water sources. The concentrations of uranium in water from these sites ranged from 0.01 to 27 pCi/L and averaged 0.73 pCi/L. The median and modal concentration ranges were 0.1 to 0.2 pCi/L and 0.02 to 0.05 pCi/L, respectively (Fig. 3.26).

3.7.2.4 Treated Waters from Municipal Water Purfication Plants — The concentrations of uranium in treated waters from the Hartford plant and all three Bridgeport facilities were below the level of detection (<0.07 pCi/L). In the New Haven system, treated water from the Whitney filter plant and Lake Gaillard each contained 0.14 pCi/L uranium. These

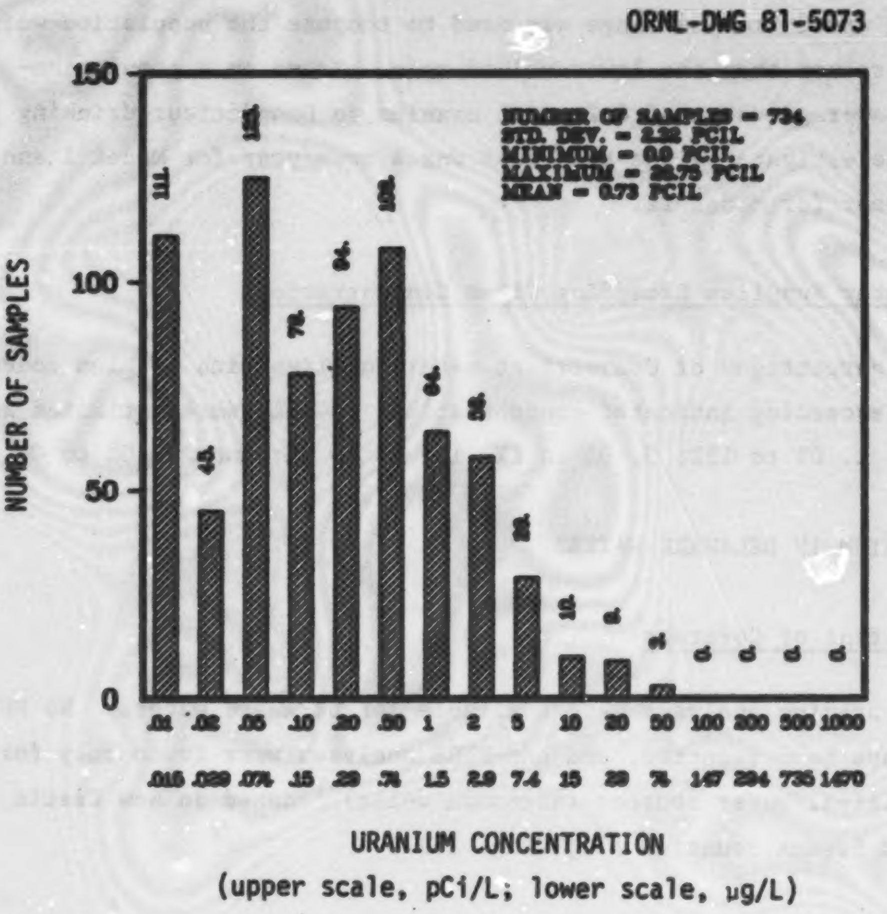

Fig. 3.26. Histogram of uranium concentrations in domestic waters of Connecticut.

data describe samples collected in 1962; however, based on experience acquired during this study, it seems probable that results for current samples will not differ greatly from those recorded here.

### 3.7.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Connecticut domestic waters was estimated as 0.2 pCi/L (Appendix 2), 15th highest among all states. This estimate is probably conservative (higher than warranted by the data) because the Connecticut domestic water histogram is not symmetrical and the higher-valued second most frequently occurring concentration range was used to compute the population-weighted average, rather than the lower-valued mode. Based on a population-weighted average value of 0.2 pCi/L uranium in Connecticut drinking water, the estimated alpha bone dose was 4 mrem/year for Model I and <1 mrem/year for Model II.

### 3.7.4 Water Supplies Exceeding Given Concentrations

The percentages of Connecticut water supplies with uranium concentrations exceeding indicated concentrations (pCi/L) were estimated as follows: 1, 0% to 15%; 5, 0% to 3%; 10, 0% to 2%; and 20, 0% to 0.4%.

## 3.8 URANIUM IN DELAWARE WATERS

### 3.8.1 Extent of Coverage

Few uranium analyses were available for Delaware waters. No NURE assays have been reported, and non-NURE analyses were found only for four municipal water sources (artesian wells) located in New Castle, Kent, and Sussex counties [15] (Fig. 3.27).

ORNL-DWG 81-5208

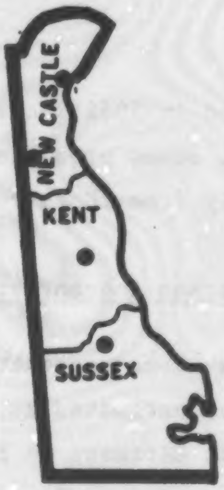

Fig. 3.27. Locations of sample sites in Delaware.

### 3.8.2 Concentrations of Uranium in Samples

3.8.2.1 Surface Waters — No analyses were available for Delaware surface waters.

3.8.2.2 Ground Waters — Water from the artesian wells in New Castle, Middletown, Dover Air Base, and Milford contained 0.07, 0.14, 0.75, and 0.20 pCi/L uranium, respectively (Fig. 3.28). These data characterize samples collected in 1952; however, the uranium content of ground waters normally changes very little with time, and it is likely that these data still accurately reflect the concentrations of uranium in current waters.

ORNL-DWG 81-5074

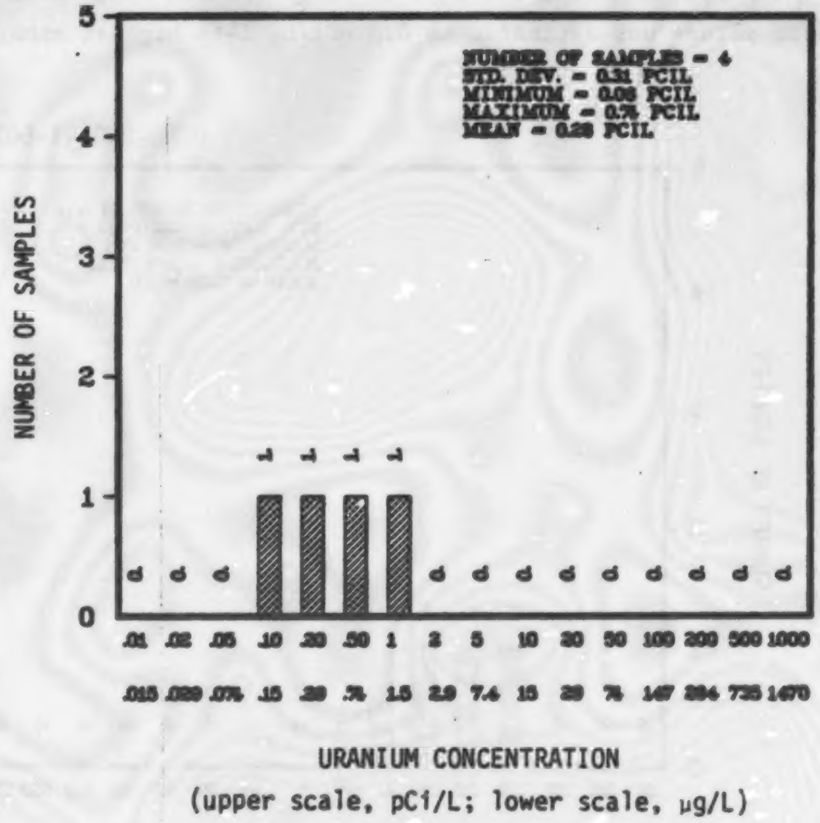

Fig. 3.28. Histogram of uranium concentrations in ground waters of Delaware.

3.8.2.3 Established Domestic and Municipal Waters — Data for the four artesian wells described in Sect. 3.8.2.2 represent the only information available for Delaware domestic or municipal waters. The concentrations of uranium in these samples ranged from 0.07 to 1 pCi/L and averaged 0.29 pCi/L. The median concentration range was 0.2 to 0.5 pCi/L (Fig. 3.29).

3.8.2.4 Treated Water from Municipal Water Purification Plants — See Sect. 3.8.2.3 for a discussion of treated water from municipal water purification plants.

### 3.8.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Delaware domestic waters was estimated as 0.3 pCi/L, 14th highest among the states

ORNL-DWG 81-5075

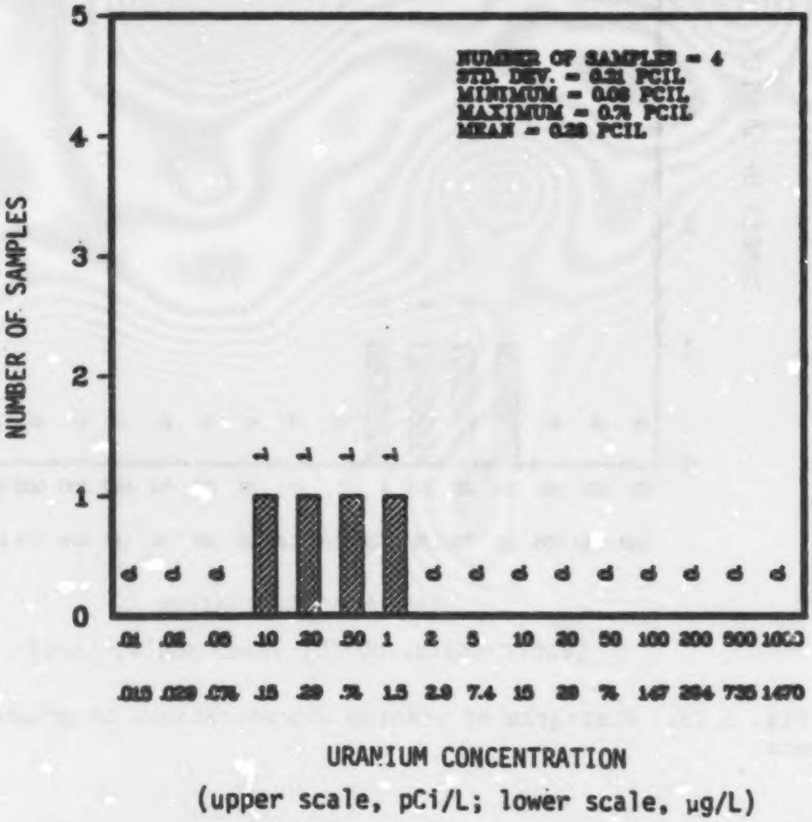

Fig. 3.29. Histogram of uranium concentrations in domestic waters of Delaware.

(Appendix 2). Based on this value, the lifetime bone dose of alpha radiation due to uranium in drinking water was estimated as 4 mrem/year for Model I and <1 mrem/year for Model II.

### 3.8.4 Water Supplies Exceeding Given Concentrations

From the limited data available, it appears that concentrations of uranium will exceed 1 pCi/L in 0% of Delaware water supplies. However, if more analyses were available we think it likely that 0% to 5% of the water supplies in Delaware might contain uranium in excess of 1 pCi/L and 0% in excess of 5 pCi/L.

## 3.9 URANIUM IN DISTRICT OF COLUMBIA WATERS

### 3.9.1 Extent of Coverage

No systematic survey of uranium in District of Columbia waters has been made; however, Durfor and Becker [26] sampled treated water from the McMillan filter plant in 1961.

### 3.9.2 Concentrations of Uranium in Samples

3.9.2.1 Surface Waters — Data were available for only one surface water site in the District of Columbia. Uranium in water from this source was below the level of detection.

3.9.2.2 Ground Waters — No data on uranium in District of Columbia ground waters were available.

3.9.2.3 Established Domestic and Municipal Waters — The District of Columbia surface water site listed in Sect. 3.9.2.1 was identified as a domestic water source. Uranium in water from this source was below the level of detection (<0.07 pCi/L).

3.9.2.4 Treated Waters from Municipal Water Purification Plants — Uranium in treated water from the McMillan filter plant was below the level of detection (<0.07 pCi/L) in 1961.

### 3.9.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in District of Columbia waters was estimated to be less than 0.1 pCi/L, 17th highest among the states (Appendix 2). The corresponding alpha radiation bone dose estimates were 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.9.4 Water Supplies Exceeding Given Concentrations

We estimate that 0% of the water in the District of Columbia water supplies will exceed 1 pCi/L of uranium.

## 3.10 URANIUM IN FLORIDA WATERS

### 3.10.1 Extent of Coverage

No NURE data were available for Florida waters; however, limited surveys and selected samples have been taken covering several areas of the state, including north-central Florida, the west-central phosphate mining region, Pensacola, Tallahassee, and the panhandle [6,15,19]. In addition, analyses of treated water were published for Jacksonville, Miami, St. Petersburg, and Tampa [1,26] (Fig. 3.30). Overall, 86 ground water sources were surveyed.

### 3.10.2 Concentrations of Uranium in Samples

3.10.2.1 Surface Waters — No data were available for Florida surface waters.

3.10.2.2 Ground Waters — Analyses were available for 86 Florida ground water samples. The concentrations of uranium in these samples ranged from 0.02 to 7.48 pCi/L and averaged 0.66 pCi/L. The median and modal concentration ranges were 0.2 to 5 pCi/L and 0.5 to 1 pCi/L, respectively (Fig. 3.31).

3.10.2.3 Established Domestic and Municipal Waters — Eighty-five of the Florida water sites were identified as domestic water sources. The concentrations of uranium in these samples ranged from 0.02 to 7

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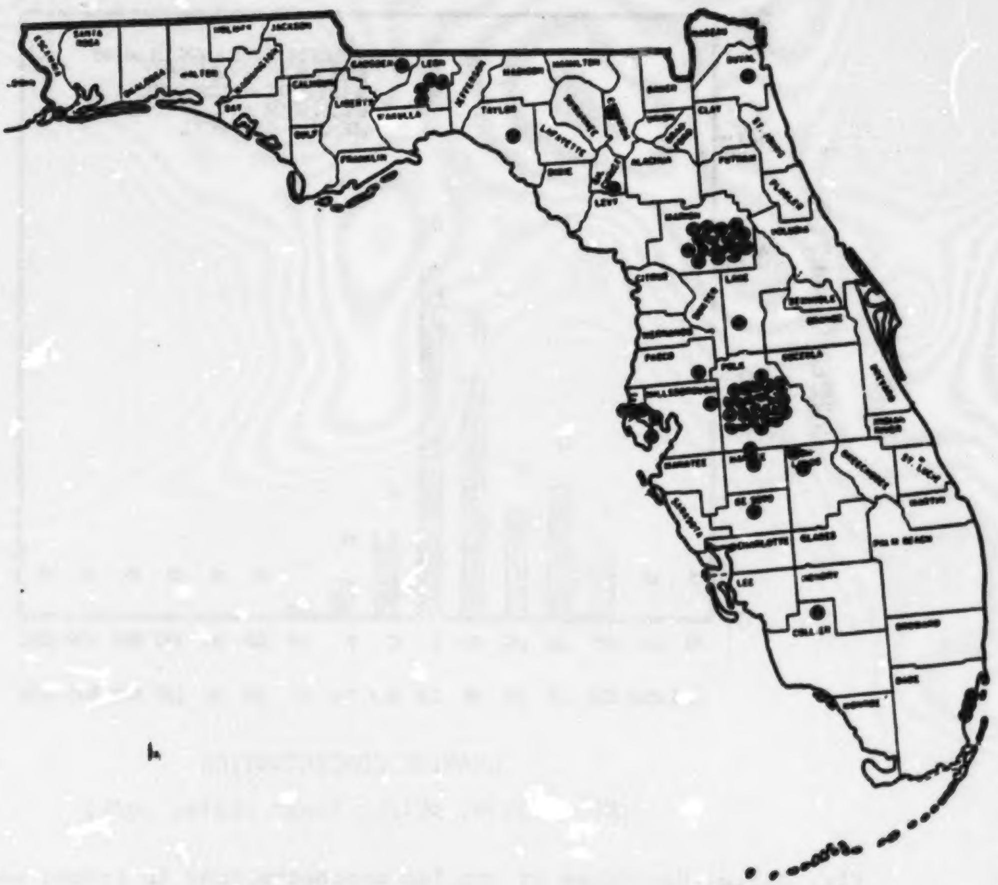
SANTA ROSA
ESCAMBIA
OKALOOSA
WALTON
HOLMES
JACKSON
WASHINGTON
BAY
CALHOUN
GULF
LIBERTY
FRANKLIN
GADSDEN
LEON
WAKULLA
JEFFERSON
MADISON
HAMILTON
TAYLOR
LAFAYETTE
SUWANNEE
DIXIE
LEVY
ALACHUA
BAKER
NASSAU
DUVAL
CLAY
ST. JOHNS
PUTNAM
FLAGLER
MARION
VOLUSIA
CITRUS
LAKE
SUMTER
HERNANDO
SEMINOLE
ORANGE
PASCO
POLK
OSCEOLA
BREVARD
HILLSBOROUGH
INDIAN RIVER
ST. LUCIE
MANATEE
HARDEE
OKEECHOBEE
MARTIN
SARASOTA
DE SOTO
CHARLOTTE
GLADES
PALM BEACH
LEE
HENDRY
COLLIER
BROWARD
DADE
MONROE

Fig. 3.30. Locations of sample sites in Florida.

pCi/L and averaged 0.65 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L and 0.5 to 1 pCi/L, respectively (Fig. 3.32).

3.10.2.4 Treated Waters from Municipal Water Purification Plants — All recorded samples of processed water collected from Florida municipal water purification plants in 1961 contained less than 1 pCi/L uranium. Finished water from the Jacksonville plant contained less than 0.1 pCi/L [26]. In Miami, water from both the Hialeah and the Orr treatment plants assayed 0.14 pCi/L. The St. Petersburg and Tampa treatment plants produced water having 0.07 and 0.27 pCi/L uranium, respectively. A more recent sample of treated water from the Miami system, composited

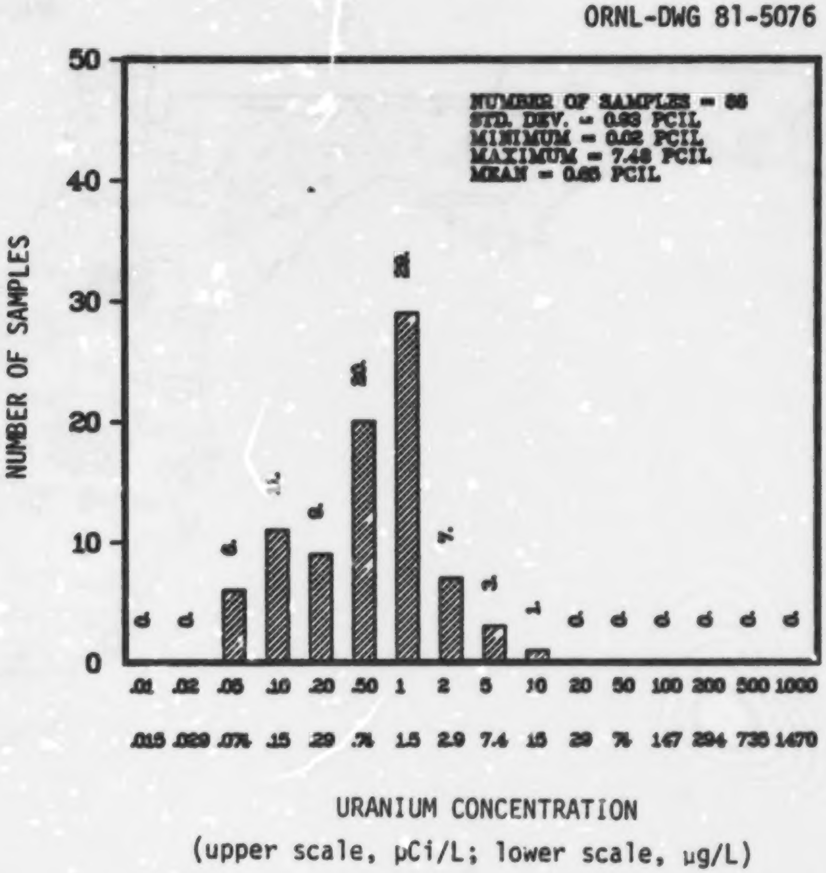

Fig. 3.31. Histogram of uranium concentrations in ground waters of Florida.

between July and December, 1977 [1], contained 0.091, 0.007, and 0.083 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total uranium activity of this sample was 0.18 pCi/L. The latter value agrees well with the value of 0.14 pCi/L reported for the 1961 sample. A similar sample composited between July 1976 and June 1977 contained 0.20 pCi/L uranium.

### 3.10.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Florida domestic waters was estimated as 0.6 pCi/L (Appendix 2). This concentration ranks 12th highest among all states. The corresponding alpha

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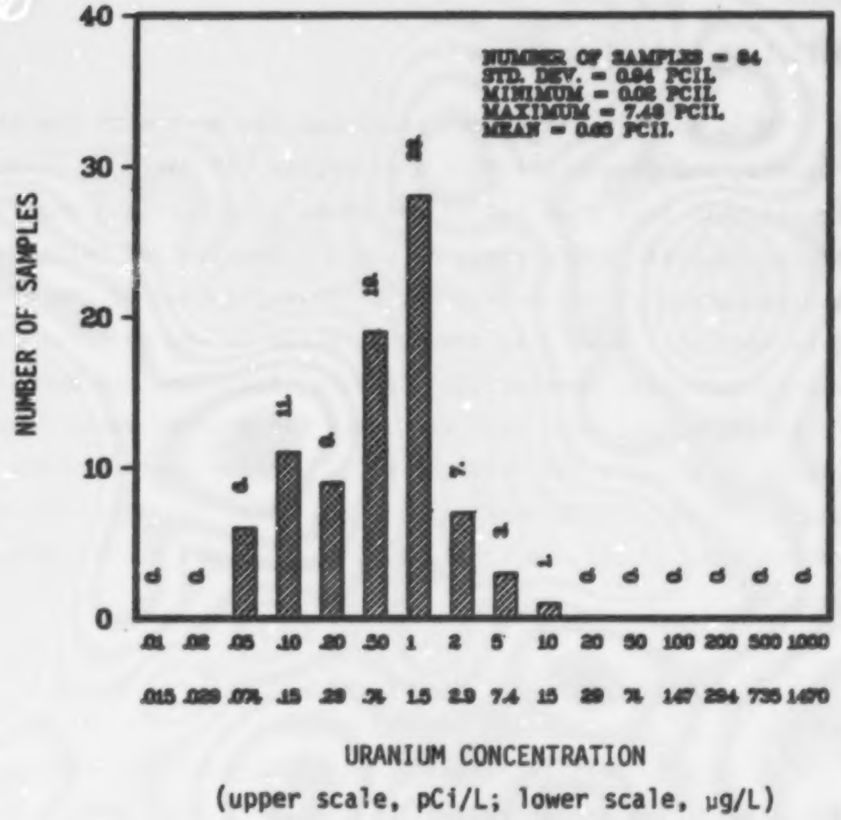

Fig. 3.32. Histogram of uranium concentrations in domestic waters of Florida.

radiation bone doses were 9 mrem/year for Model I and <1 mrem/year for Model II.

### 3.10.4 Water Supplies Exceeding Given Concentrations

Approximately 10% to 13% of Florida water supplies are estimated to have uranium concentrations exceeding 1 pCi/L, but only 0% to 1% are expected to exceed 5 pCi/L. Based on available data few. if any, sources are expected to exceed 10 pCi/L.

## 3.11 URANIUM IN GEORGIA WATERS

### 3.11.1 Extent of Coverage

NURE analyses have been published for waters of the Athens, Atlanta, Augusta, and Greenville NTMS quadrangles [69,76-78]. These areas amount to slightly less than 30% of the state's surface and correspond to all of the counties lying north of the 33d parallel of latitude except for approximately 15 in the extreme northwest corner of the state. Non-NURE data were also available for other sites in the northern part of the state, including Dawsonville, Suwanee, Eatonton, and Sandersville [15]. In addition, analyses were available for treated water from municipal plants in Atlanta and Savannah [26]. The southern portion of the state has not been so well sampled, but one assay was available for water from Edison (Fig. 3.33). Overall, 1700 surface and ground water sites were sampled.

### 3.11.2 Concentrations of Uranium in Samples

3.11.2.1 Surface Waters — Only 5 surface water analyses were available. The concentration of uranium in this small sample set ranged from 0.07 to 0.27 pCi/L and averaged 0.16 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.34).

3.11.2.2 Ground Waters — Uranium analyses were available for 1695 Georgia ground water samples. The concentrations of uranium in these samples ranged from 0.01 to 287.77 pCi/L and averaged 0.41 pCi/L. The mode was 0.01 pCi/L, and the median concentration range was 0.02 to 0.05 pCi/L (Fig. 3.35).

3.11.2.3 Established Domestic and Municipal Waters — Sixteen hundred forty-six of the Georgia sample sites were identified as domestic water sources. Uranium in these samples ranged from 0.01 to 288 pCi/L and averaged 0.41 pCi/L. The median concentration range was 0.02 to 0.05 pCi/L, and the mode was 0.01 pCi/L (Fig. 3.36).

3.11.2.4 Treated Waters from Municipal Water Purification Plants — Analyses were available for treated water from municipal water purification plants in Atlanta and Savannah [15,26]. The concentrations of uranium were below the limit of detection (<0.07 pCi/L) in both the

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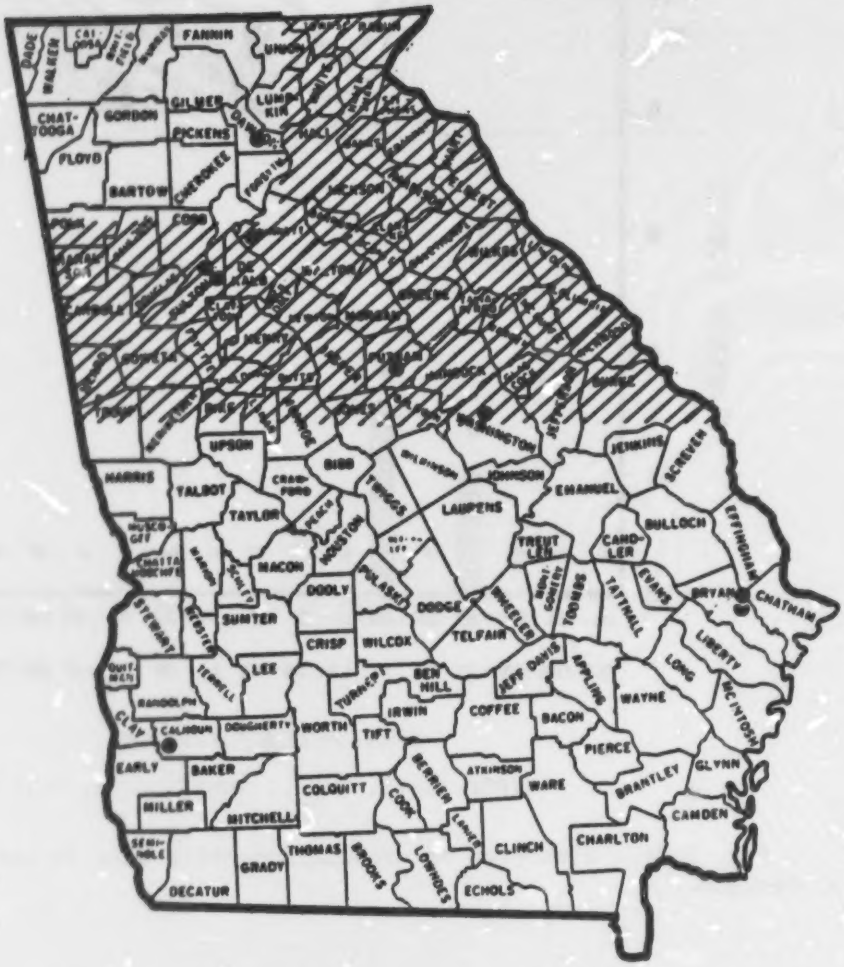

DADE
WALKER
CATOOSA
FANNIN
UNION
GILMER
LUMPKIN
CHATTOOGA
GORDON
PICKENS
FLOYD
BARTOW
CHEROKEE
COBB
HENRY
MORGAN
PUTNAM
HANCOCK
WASHINGTON
JEFFERSON
BURKE
JONES
UPSON
BIBB
HARRIS
TALBOT
CRAWFORD
TAYLOR
PEACH
HOUSTON
TWIGGS
WILKINSON
JOHNSON
EMANUEL
JENKINS
SCREVEN
LAURENS
BULLOCH
EFFINGHAM
MUSCOGEE
CHATTAHOOCHEE
MARION
SCHLEY
MACON
DOOLY
PULASKI
BLECKLEY
DODGE
TREUTLEN
CANDLER
WHEELER
MONTGOMERY
TOOMBS
TATTNALL
EVANS
BRYAN
CHATHAM
STEWART
WEBSTER
SUMTER
CRISP
WILCOX
TELFAIR
LIBERTY
LONG
QUITMAN
RANDOLPH
TERRELL
LEE
TURNER
BEN HILL
JEFF DAVIS
APPLING
WAYNE
MC INTOSH
CLAY
CALHOUN
DOUGHERTY
WORTH
TIFT
IRWIN
COFFEE
BACON
PIERCE
EARLY
BAKER
BERRIEN
ATKINSON
WARE
BRANTLEY
GLYNN
MILLER
MITCHELL
COLQUITT
COOK
LANIER
CLINCH
CHARLTON
CAMDEN
SEMINOLE
DECATUR
GRADY
THOMAS
BROOKS
LOWNDES
ECHOLS

Fig. 3.33. Locations of sample sites in Georgia.

Hemphill filter plant (Atlanta) and the Cherokee Hill treatment plant (Savannah) in the 1964 survey. The earlier study reported 3.4 pCi/L uranium in Atlanta water and 0.27 pCi/L in treated water from the Savannah system.

### 3.11.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Georgia domestic water was estimated as <0.1 pCi/L, 17th highest among all states

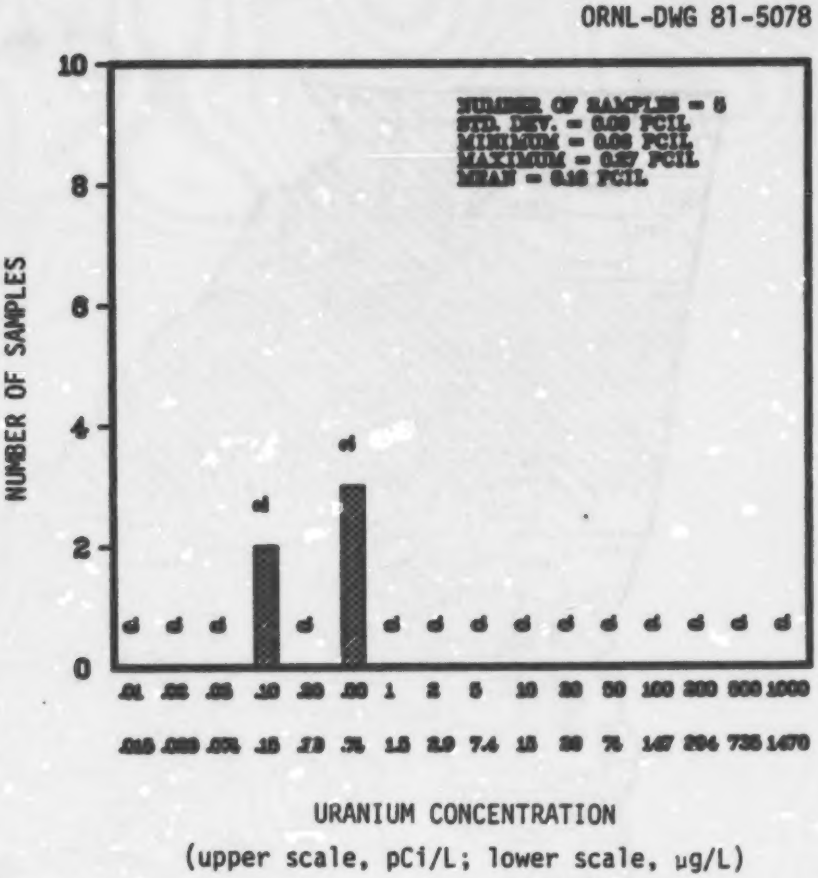


Fig. 3.34. Histogram of uranium concentrations in surface waters of Georgia.

(Appendix 2). The corresponding alpha radiation bone doses were <1 mrem/year for both Model I and Model II.

### 3.11.4 Water Supplies Exceeding Given Concentrations

The percent of Georgia water supplies with uranium exceeding indicated concentrations (pCi/L) were estimated as follows: 1, 0% to 3%; 5, 0% to 0.7%; 10, 0% to 0.4%; and 20, 0% to 0.2%.

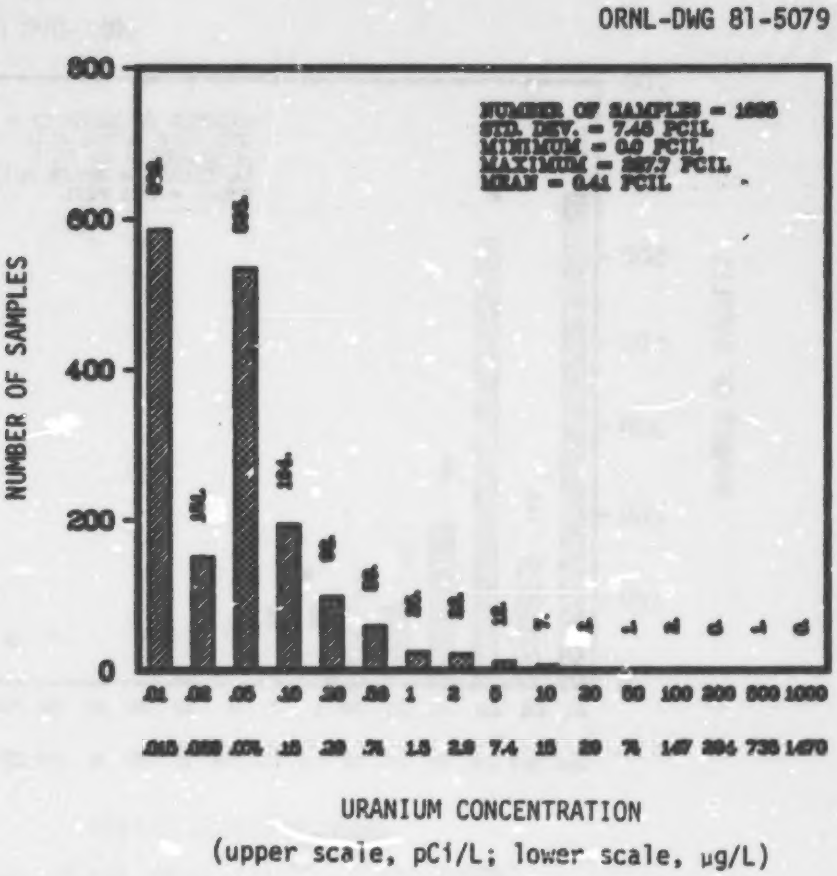


Fig. 3.35. Histogram of uranium concentrations in ground waters of Georgia.

## 3.12 URANIUM IN HAWAII WATERS

### 3.12.1 Extent of Coverage

No measurements of uranium in Hawaiian waters were found, except for samples of raw well water from the Kaimuki, Beretania, and Kalihi pumping stations [26] in Honolulu (Fig. 3.37).

### 3.12.2 Concentrations of Uranium in Samples

3.12.2.1 Surface Waters — No Hawaiian surface water data were available.

ORNL-DWG 81-5080

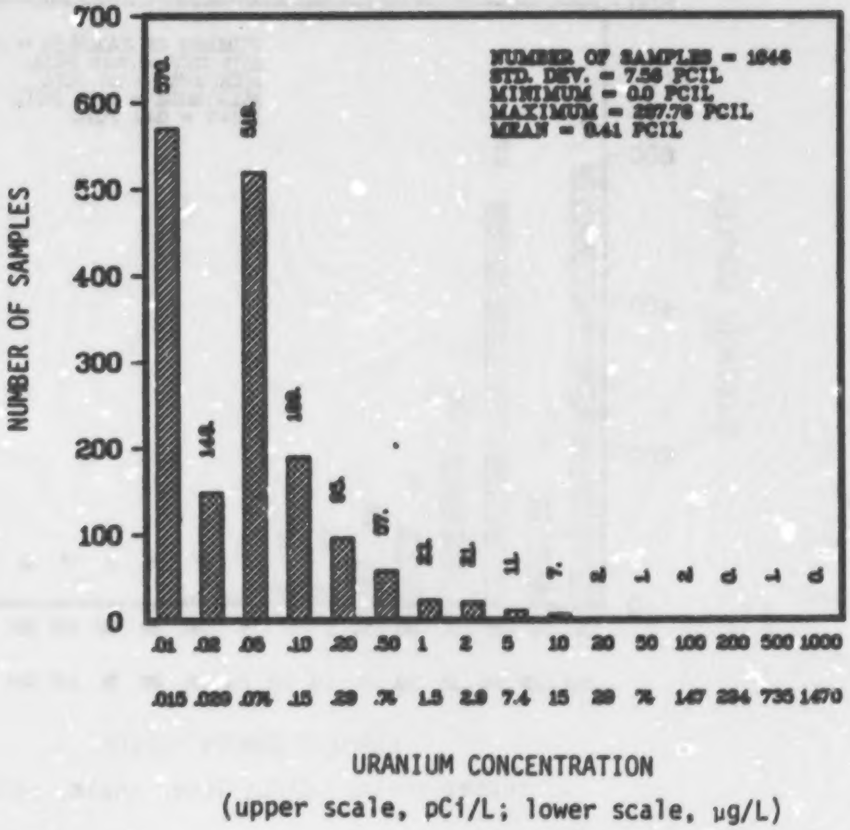


Fig. 3.36. Histogram of uranium concentrations in domestic waters of Georgia.

3.12.2.2 Ground Waters — The concentrations of uranium in the raw well waters from three Honolulu pumping stations were below the limit of detection (Fig. 3.38).

3.12.2.3 Established Domestic and Municipal Waters — All three Hawaiian sample sites were identified as domestic water sources. The concentrations of uranium in these samples were below the limit of detection (Fig. 3.39).

3.12.2.4 Treated Waters from Municipal Water Purification Plants — No analyses were available.

ORNL-DWG 81-5211

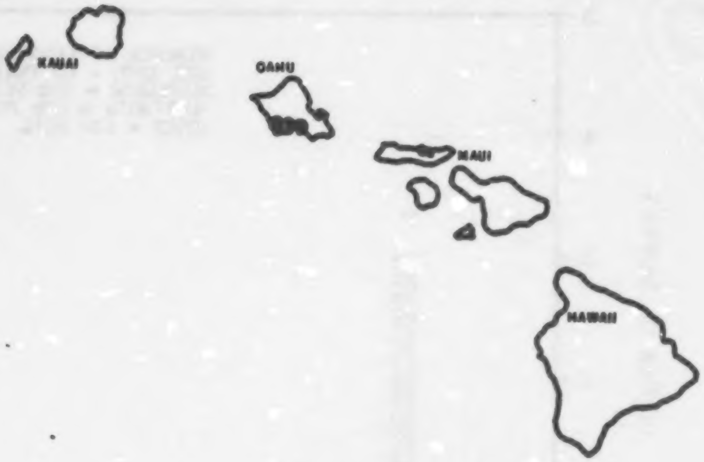

KAUAI
OAHU
MAUI
HAWAII

Fig. 3.37. Locations of sample sites in Hawaii.

ORNL-DWG 81-5081

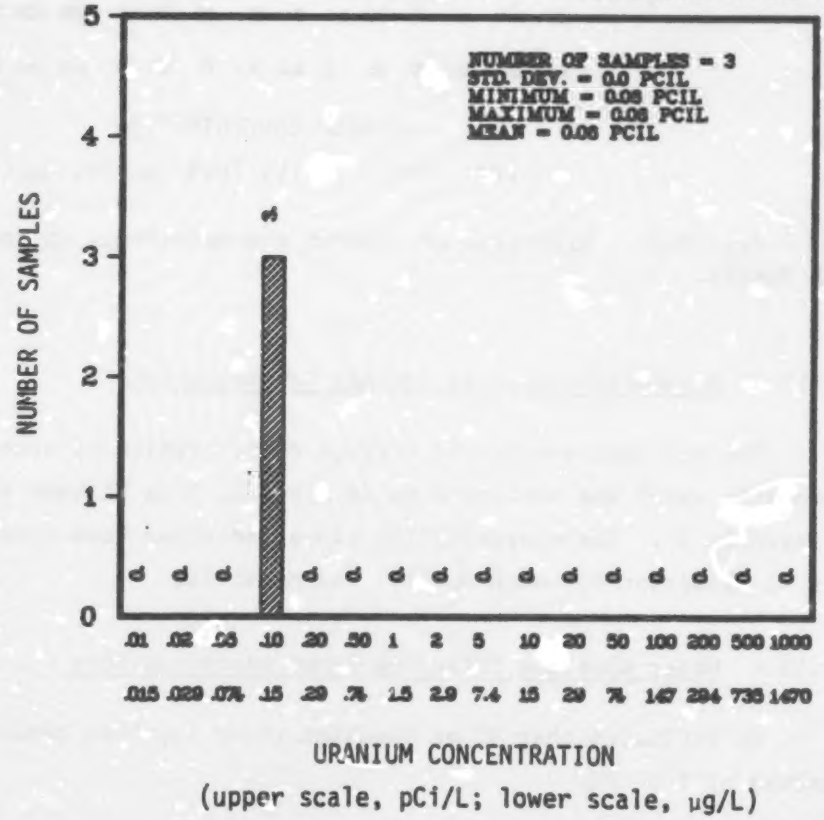


Fig. 3.38. Histogram of uranium concentrations in ground waters of Hawaii.

ORNL-DWG 81-5082

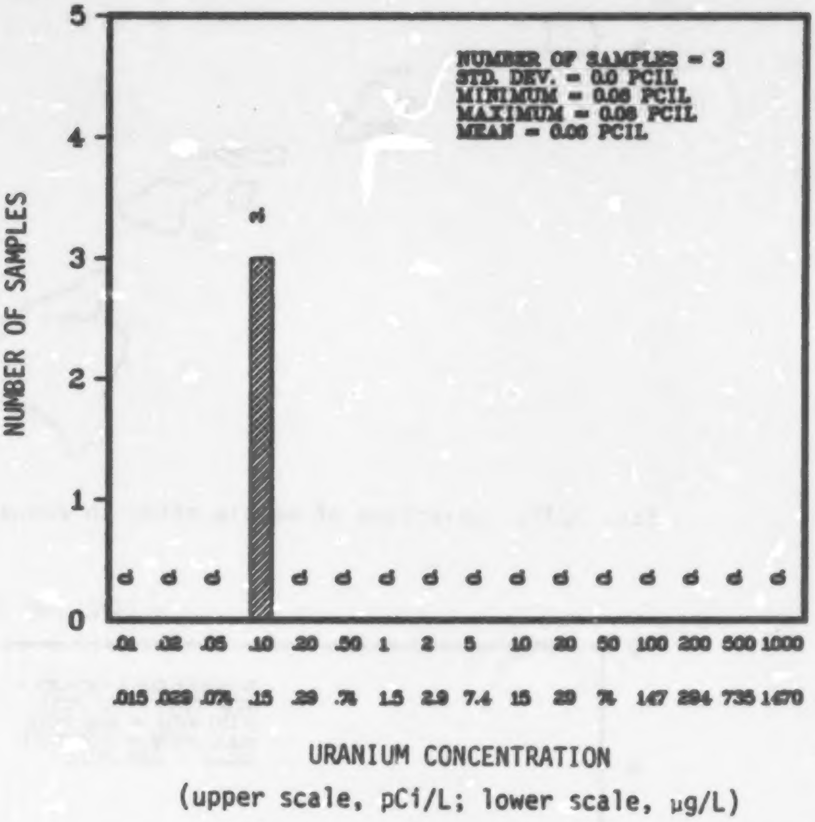


Fig. 3.39. Histogram of uranium concentrations in domestic waters of Hawaii.

### 3.12.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Hawaiian domestic water was estimated as <0.1 pCi/L, 17th highest among all states (Appendix 2). The corresponding alpha radiation bone doses were estimated as <1 mrem/year for both Model I and Model II.

### 3.12.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% of Hawaiian water supplies contain uranium in excess of 1 pCi/L.

## 3.13 URANIUM IN IDAHO WATERS

### 3.13.1 Extent of Coverage

NURE personnel have reported uranium analyses for about 9% of the state's area, primarily the northern counties, Boundary and Bonner, that lie within the Sandpoint NTMS quadrangle [86] and the northeastern portion of Lemhi county that is contained in the Dillon NTMS quadrangle [33]. In addition, a creek in Kaufman (Clark County), a spring in Ririe (Bonneville County), and a well in Bruneau (Owyhee County) were sampled by Scott and Barker [15]. Felmlee and Cadigan [17] sampled five mineral springs at various locations within the state. Composite samples of water from the Idaho Falls community supply were also taken [1]. Overall, 316 surface and ground water sites were surveyed (Fig, 3.40).

### 3.13.2 Concentration of Uranium in Samples

3.13.2.1 Surface Waters — Of the 316 sources described above, 149 provided surface water samples in which the concentrations of uranium ranged from 0.01 to 53.93 pCi/L and averaged 1.04 pCi/L. The modal and median concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.41).

3.13.2.2 Ground Waters — One hundred sixty-seven of the Idaho sample sites produced ground water samples. The concentrations of uranium in these samples ranged from 0.01 to 73.37 pCi/L and averaged 1.00 pCi/L. The median and modal concentration ranges were 0.1 to 0.2 pCi/L and 0.02 to 0.05 pCi/L, respectively (Fig. 3.42).

3.13.2.3 Established Domestic and Municipal Waters — Forty-two Idaho sample sites were identified as domestic water sources. Uranium in water from these sites varied from 0.02 to 73 pCi/L and averaged 2.25 pCi/L. The most frequently occurring concentration ranges were 0.1 to 0.2 pCi/L and 0.5 to 1.00 pCi/L. The median concentration range was 0.1 to 0.2 pCi/L (Fig. 3.43).

3.13.2.4 Treated Waters from Municipal Water Purification Plants — No Idaho samples were identified for this category.

ORNL-DWG 81-5212

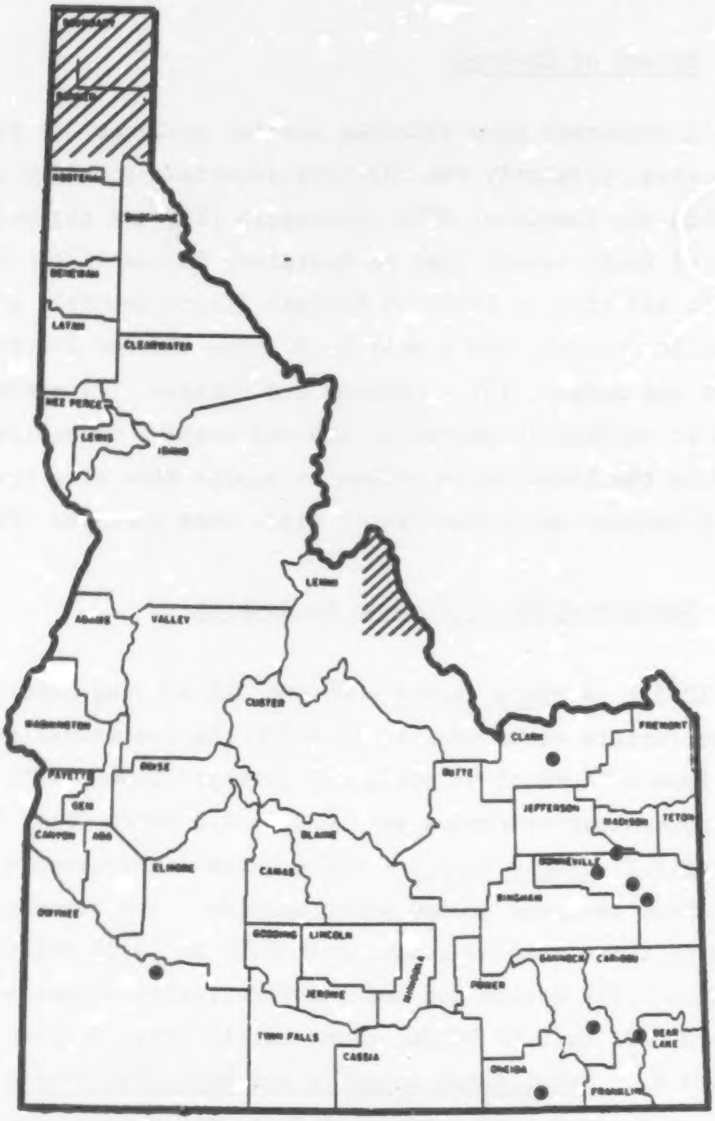

KOOTENAI
SHOSHONE
BENEWAH
LATAH
CLEARWATER
NEZ PERCE
LEWIS
IDAHO
LEMHI
ADAMS
VALLEY
CUSTER
WASHINGTON
CLARK
FREMONT
PAYETTE
BOISE
BUTTE
GEM
JEFFERSON
MADISON
TETO
CANYON
ADA
BLAINE
ELMORE
BONNEVILLE
CAMAS
BINGHAM
OWYHEE
GOODING
LINCOLN
MINIDOKA
BANNOCK
CARIBOU
POWER
JEROME
TWIN FALLS
BEAR LAKE
CASSIA
ONEIDA
FRANKLI

Fig. 3.40. Locations of sample sites in Idaho.

### 3.13.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Idaho domestic water was estimated to be 0.8 pCi/L, 10th highest among the states (Appendix 2). This estimate may be conservative (higher than the

ORNL-DWG 81-5083

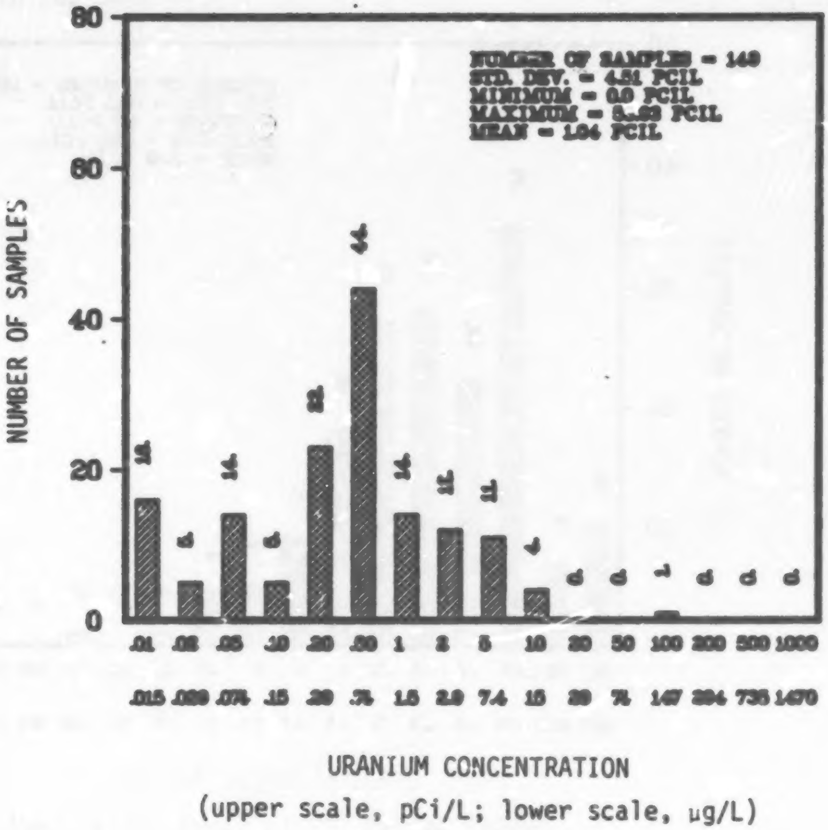


Fig. 3.41. Histogram of uranium concentrations in surface waters of Idaho.

data require) because the Idaho domestic water histogram is twin-peaked and the higher-valued peak was used to estimate the population-weighted average. Based on the 0.8 pCi/L value, the alpha radiation bone dose estimate is 11 mrem/year for Model I and <1 mrem/year for Model II.

### 3.13.4 Water Supplies Exceeding Given Concentrations

The percentages of Idaho water supplies with uranium exceeding the indicated concentrations (pCi/L) were estimated as follows: 1, 0% to 13%; 5, 0% to 3%; 10, 0%; and 20, 0%.

ORNL-DWG 81-5084

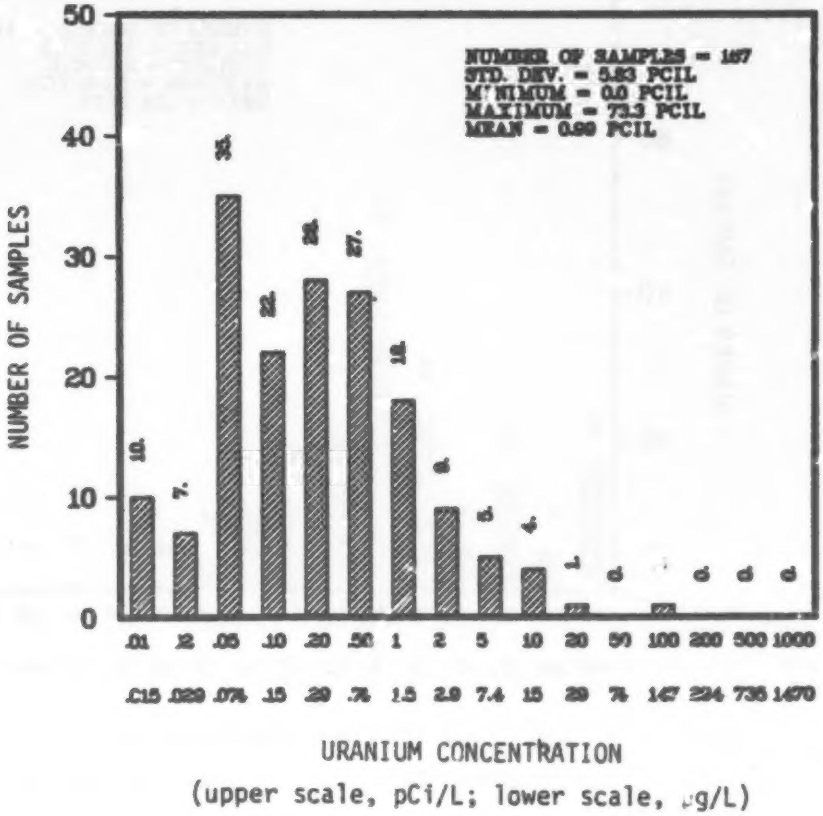


Fig. 3.42. Histogram of uranium concentrations in ground waters of Idaho.

## 3.14 URANIUM IN ILLINOIS WATERS

### 3.14.1 Extent of Coverage

No systematic survey of uranium in Illinois waters was found. However, analyses of selected samples were available for six towns scattered more or less uniformly throughout the state [15] and for treated water from municipal plants in Chicago and Rockford [26]. Overall, 11 surface and ground water sites were sampled (Fig. 3.44).

ORNL-DWG 81-5085

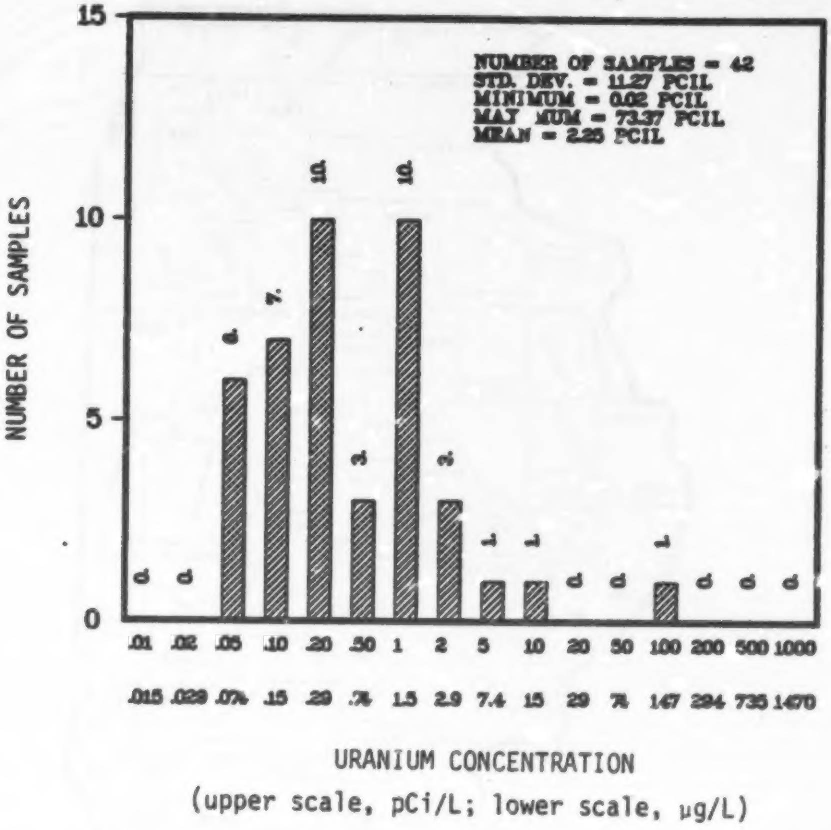


Fig. 3.43. Histogram of uranium concentrations in domestic waters of Idaho.

### 3.14.2 Concentrations of Uranium in Samples

3.14.2.1 Surface Waters — Three of the eleven samples were surface water. Uranium in these samples varied from 0.07 to 0.13 pCi/L and averaged 0.09 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.45).

3.14.2.2 Ground Waters — There were eight Illinois ground water samples in which the concentrations of uranium varied from 0.07 to 0.54 pCi/L and averaged 0.29 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.46).

ORNL-DWG 81-5213

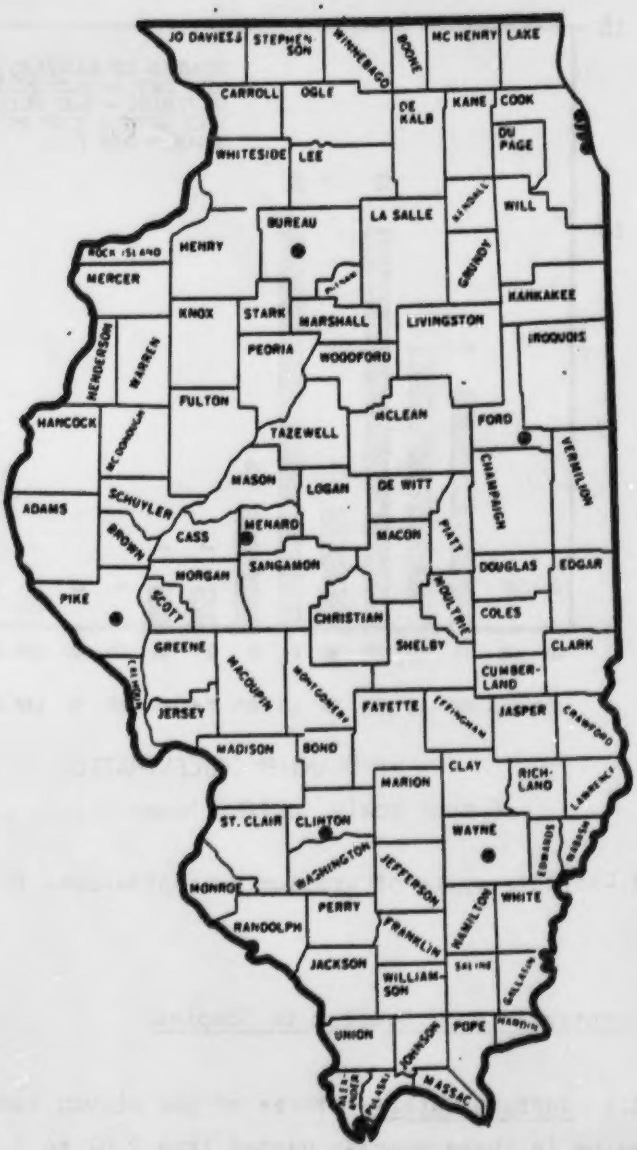

JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
MC HENRY
LAKE
CARROLL
OGLE
DE KALB
KANE
COOK
DU PAGE
WHITESIDE
LEE
WILL
KENDALL
LA SALLE
BUREAU
ROCK ISLAND
HENRY
MERCER
PUTNAM
GRUNDY
KANKAKEE
KNOX
STARK
MARSHALL
LIVINGSTON
IROQUOIS
HENDERSON
WARREN
PEORIA
WOODFORD
FULTON
HANCOCK
MC DONOUGH
TAZEWELL
MCLEAN
FORD
VERMILION
MASON
LOGAN
DE WITT
CHAMPAIGN
ADAMS
SCHUYLER
BROWN
CASS
MENARD
MACON
PIATT
MORGAN
SANGAMON
DOUGLAS
EDGAR
PIKE
SCOTT
MOULTRIE
CHRISTIAN
COLES
GREENE
SHELBY
CLARK
CALHOUN
MACOUPIN
MONTGOMERY
CUMBERLAND
JERSEY
FAYETTE
EFFINGHAM
JASPER
CRAWFORD
MADISON
BOND
CLAY
RICHLAND
LAWRENCE
MARION
ST. CLAIR
CLINTON
WAYNE
EDWARDS
WABASH
MONROE
WASHINGTON
JEFFERSON
HAMILTON
WHITE
RANDOLPH
PERRY
FRANKLIN
JACKSON
WILLIAMSON
SALINE
GALLATIN
UNION
JOHNSON
POPE
HARDIN
ALEXANDER
PULASKI
MASSAC

Fig. 3.44. Locations of sample sites in Illinois.

3.14.2.3 Established Domestic and Municipal Waters — All but one of the listed samples were domestic or municipal types. The concentrations of uranium in these samples ranged from the limit of detection, 0.07 pCi/L, to 0.54 pCi/L and averaged 0.22 pCi/L. The median concentration range was 0.1 to 0.2 pCi/L. The modal concentration ranges were 0.05 to 0.10 pCi/L and 0.2 to 0.5 pCi/L (Fig. 3.47).

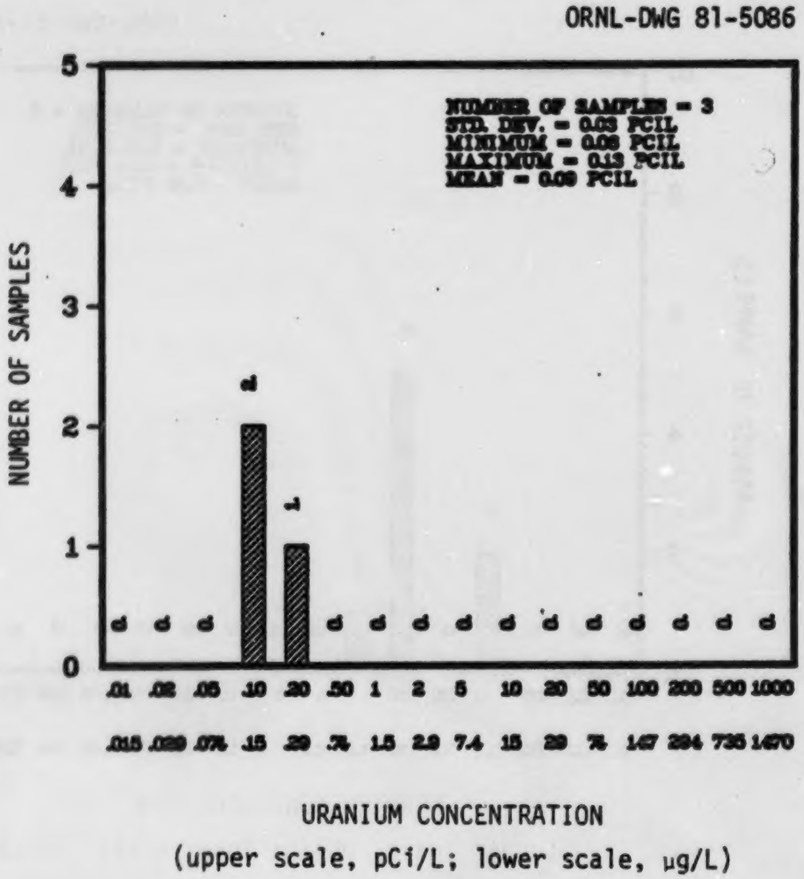
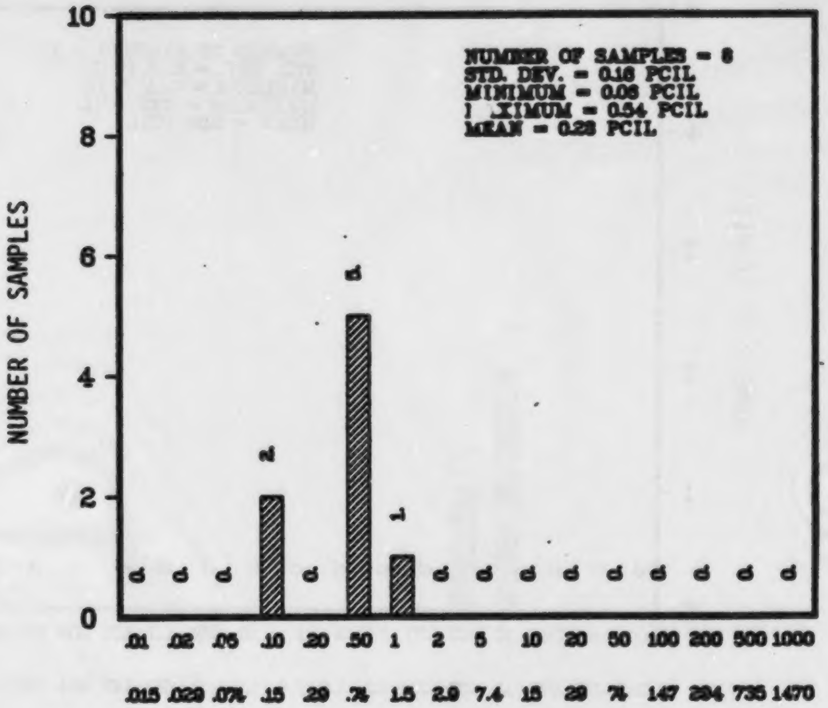


Fig. 3.45. Histogram of uranium concentrations in surface waters of Illinois.

3.14.2.4 Treated Waters from Municipal Water Purification Plants — Data were available for treated waters from the Chicago and Rockford municipal purification plants. Samples taken from the Chicago system in 1961 contained 0.07, 0.07, and 0.14 pCi/L uranium for the Chicago Avenue station, the Lake View station, and the South District filtration plant, respectively [26]. A more recent sample from the Chicago system, composited between July and December, 1977, contained 0.182, 0.015, and 0.182 pCi/L of $^{234}$U, $^{235}$U, and $^{238}$U, respectively [1]. The total uranium radioactivity of this sample was 0.379 pCi/L.

A 1961 sample of water composited from six group wells in the Rockford municipal water system contained 0.41 pCi/L uranium [26].

ORNL-DWG 81-5087



URANIUM CONCENTRATION
(upper scale, pCi/L; lower scale, μg/L)

Fig. 3.46. Histogram of uranium concentrations in ground waters of Illinois.

### 3.14.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Illinois domestic waters was estimated as 0.3 pCi/L, 14th highest among all states. This value may be conservative (higher than the data warrant) because the Illinois domestic water histogram is twin-peaked and the higher-valued peak was used in estimating the population-weighted average. Based on this average, the alpha radiation bone dose estimate is 5 mrem/year for Model I and <1 mrem/year for Model II.

ORNL-DWG 81-5088

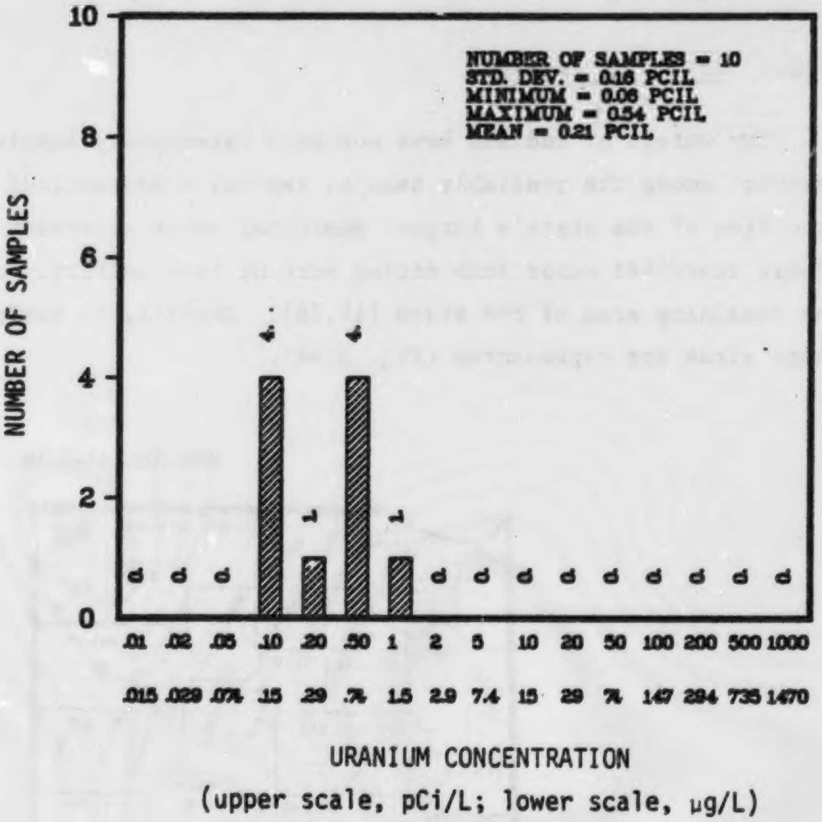


**Fig. 3.47. Histogram of uranium concentrations in domestic waters of Illinois.**

### 3.14.4 Water Supplies Exceeding Given Concentrations

**Based on the data at hand it appears that 0% of Illinois water supplies will have uranium concentrations exceeding 1 pCi/L. However, the data for Illinois are too limited to foster a high degree of confidence in this estimate. Intuitively, we suggest that 0% to 5% of the water supplies in Illinois may exceed 1 pCi/L, but that few, if any, will exceed 5 pCi/L.**

## 3.15 URANIUM IN INDIANA WATERS

### 3.15.1 Extent of Coverage

The waters of Indiana have not been extensively sampled for uranium; however, among the available assays, several characterized treated water from five of the state's largest mumicipal water treatment systems, and others described water from cities more or less uniformly dispersed over the remaining area of the state [15,26]. Overall, 16 surface and ground water sites are represented (Fig. 3.48).

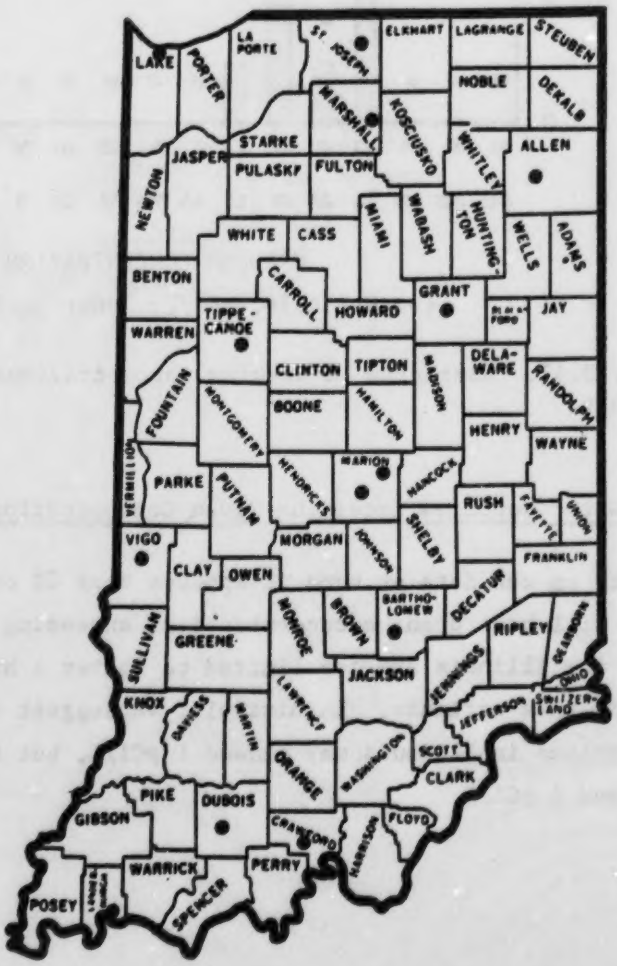

ORNL-DWG 81-5214
LAKE
PORTER
LA PORTE
ST JOSEPH
ELKHART
LAGRANGE
STEUBEN
NOBLE
DEKALB
MARSHALL
KOSCIUSKO
WHITLEY
ALLEN
STARKE
JASPER
PULASKI
FULTON
NEWTON
MIAMI
WABASH
HUNTINGTON
WELLS
ADAMS
WHITE
CASS
BENTON
CARROLL
GRANT
HOWARD
BLACKFORD
JAY
WARREN
TIPPECANOE
CLINTON
TIPTON
MADISON
DELAWARE
RANDOLPH
FOUNTAIN
MONTGOMERY
BOONE
HAMILTON
HENRY
WAYNE
VERMILLION
PARKE
PUTNAM
HENDRICKS
MARION
HANCOCK
RUSH
FAYETTE
UNION
VIGO
MORGAN
JOHNSON
SHELBY
FRANKLIN
CLAY
OWEN
MONROE
BROWN
BARTHOLOMEW
DECATUR
RIPLEY
DEARBORN
SULLIVAN
GREENE
JACKSON
JENNINGS
OHIO
KNOX
DAVIESS
MARTIN
LAWRENCE
JEFFERSON
SWITZERLAND
WASHINGTON
SCOTT
ORANGE
CLARK
PIKE
DUBOIS
GIBSON
CRAWFORD
FLOYD
HARRISON
WARRICK
PERRY
POSEY
VANDERBURGH
SPENCER

Fig. 3.48. Locations of sample sites in Indiana.

### 3.15.2 Concentrations of Uranium in Samples

3.15.2.1 Surface Waters — Five Indiana surface water analyses were found. The concentrations of uranium in these samples ranged from 0.07 to 0.88 pCi/L and averaged 0.42 pCi/L. The median concentration range was 0.2 to 0.5 pCi/L. The modal concentration ranges were 0.05 to 0.1 pCi/L and 0.5 to 1 pCi/L (Fig. 3.49).

3.15.2.2 Ground Waters — Twelve Indiana sites produced ground water samples. The concentrations of uranium in these samples varied from 0.07 to 1.36 pCi/L and averaged 0.39 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.50).

ORNL-DWG 81-5089

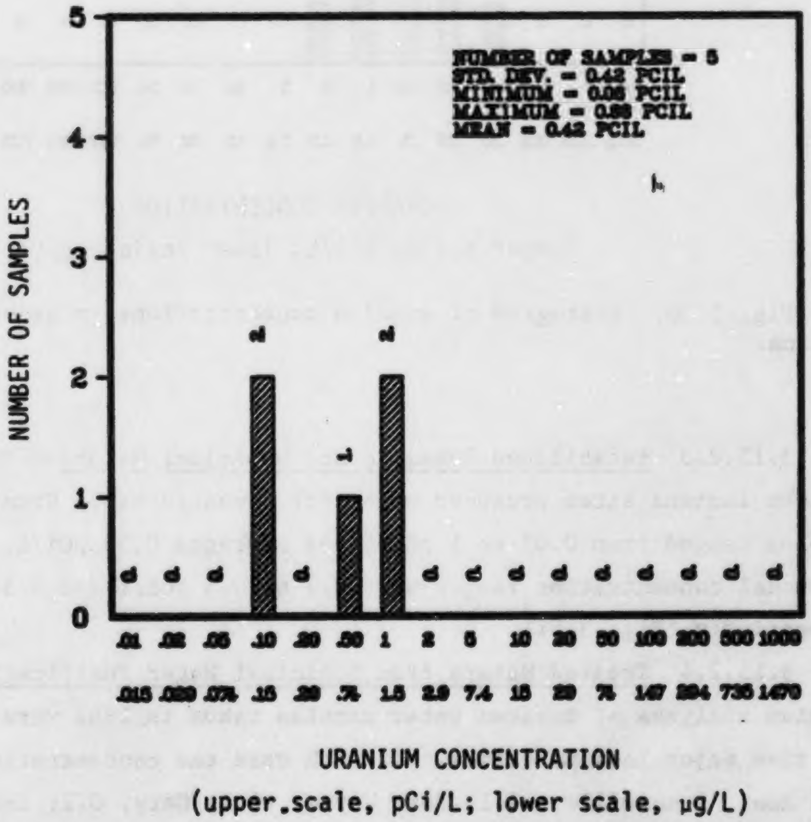


Fig. 3.49. Histogram of uranium concentrations in surface waters of Indiana.

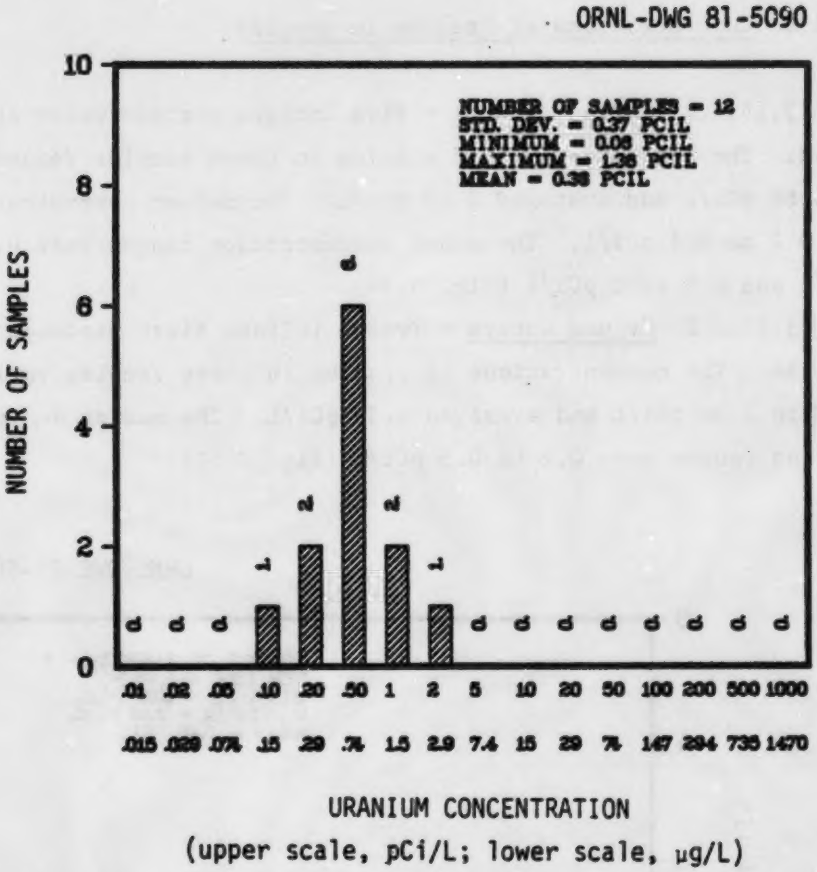


**Fig. 3.50. Histogram of uranium concentrations in ground waters of Indiana.**

**3.15.2.3 Established Domestic and Municipal Waters — Twelve of the sixteen Indiana sites produced water for domestic use. Uranium in these samples ranged from 0.07 to 1 pCi/L and averaged 0.36 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L and 0.5 to 1 pCi/L, respectively (Fig. 3.51).**

**3.15.2.4 Treated Waters from Municipal Water Purification Plants — Uranium analyses of treated water samples taken in 1962 were available for five major Indiana cities. In each case the concentrations (pCi/L) were low: Evansville, <0.1; Fort Wayne, <0.1; Gary, 0.2; Indianapolis, 0.88 (Fall Creek), 0.88 (White River); and South Bend, 0.14 (Coquillard Station, Well No. 3), 0.14 (Pinhook Station, Well No. 3), 0.2 (North Station, Wells No. 5 and No. 7).**

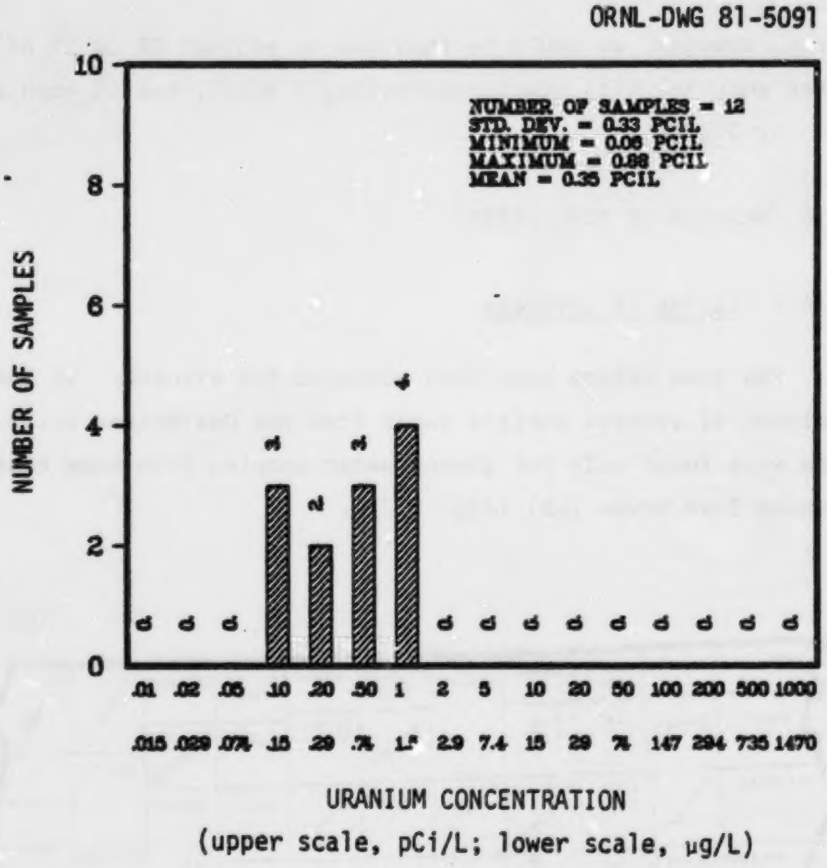


Fig. 3.51. Histogram of uranium concentrations in domestic waters of Indiana.

### 3.15.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Indiana domestic water was estimated as 0.6 pCi/L, 12th highest among the states (Appendix 2). The corresponding alpha radiation bone dose estimates were 10 mrem/year for Model I and <1 mrem/year for Model II.

### 3.15.4 Water Supplies Exceeding Given Concentrations

Based on the limited information at hand, it appears that 0% of Indiana water supplies have uranium exceeding 1 pCi/L. On an intuitive basis, however, we would be inclined to project 0% to 5% of Indiana water supplies with uranium exceeding 1 pCi/L, but 0% with uranium exceeding 5 pCi/L.

## 3.16 URANIUM IN IOWA WATERS

### 3.16.1 Extent of Coverage

Few Iowa waters have been surveyed for uranium. In addition to an analysis of treated surface water from the Des Moines Water Works [26], data were found only for ground water samples from nine central or eastern Iowa towns [15] (Fig. 3.52).

ORNL-DWG 81-5215

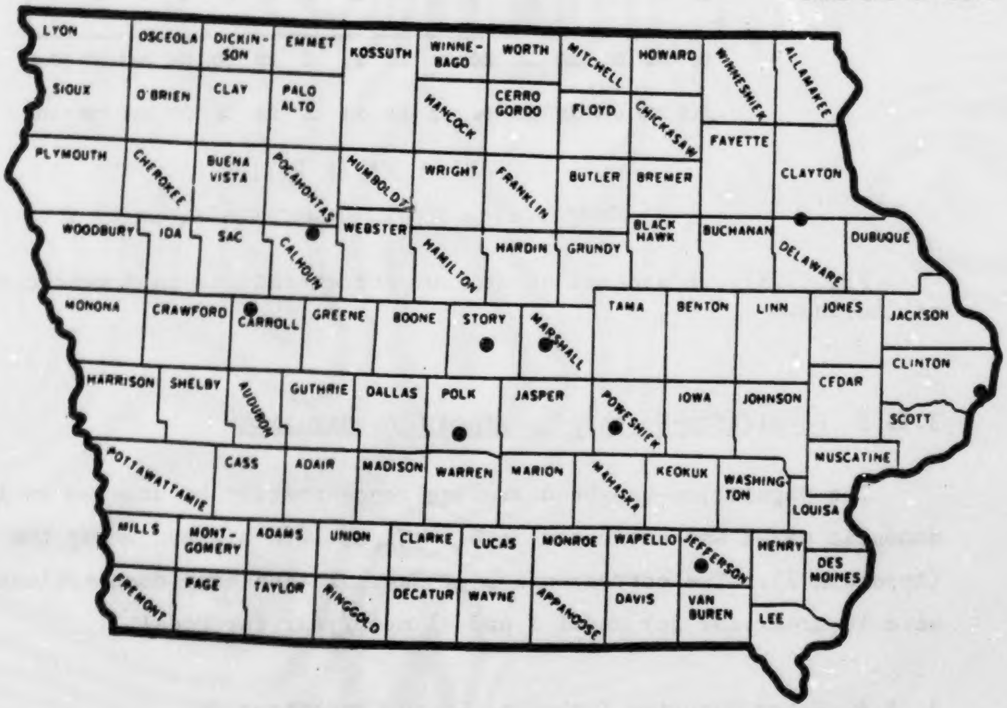

LYON
OSCEOLA
DICKIN-SON
EMMET
KOSSUTH
WINNE-BAGO
WORTH
MITCHELL
HOWARD
WINNESHIEK
ALLAMAKEE
SIOUX
O'BRIEN
CLAY
PALO ALTO
HANCOCK
CERRO GORDO
FLOYD
CHICKASAW
FAYETTE
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
HUMBOLDT
WRIGHT
FRANKLIN
BUTLER
BREMER
CLAYTON
WOODBURY
IDA
SAC
CALHOUN
WEBSTER
HAMILTON
HARDIN
GRUNDY
BLACK HAWK
BUCHANAN
DELAWARE
DUBUQUE
MONONA
CRAWFORD
CARROLL
GREENE
BOONE
STORY
MARSHALL
TAMA
BENTON
LINN
JONES
JACKSON
HARRISON
SHELBY
AUDUBON
GUTHRIE
DALLAS
POLK
JASPER
POWESHIEK
IOWA
JOHNSON
CEDAR
CLINTON
SCOTT
POTTAWATTAMIE
CASS
ADAIR
MADISON
WARREN
MARION
MAHASKA
KEOKUK
WASHING-TON
MUSCATINE
LOUISA
MILLS
MONT-GOMERY
ADAMS
UNION
CLARKE
LUCAS
MONROE
WAPELLO
JEFFERSON
HENRY
DES MOINES
FREMONT
PAGE
TAYLOR
RINGGOLD
DECATUR
WAYNE
APPANOOSE
DAVIS
VAN BUREN
LEE

Fig. 3.52. Locations of sample sites in Iowa.

### 3.16.2 Concentrations of Uranium in Samples

3.16.2.1 Surface Waters — The one recorded Iowa surface water sample contained 1.29 pCi/L uranium (Fig. 3.53).

3.16.2.2 Ground Waters — Uranium in the nine Iowa ground water samples ranged from 0.07 to 4.21 pCi/L and averaged 0.75 pCi/L. The median concentration range was 0.2 to 0.5 pCi/L. The most frequently occurring concentration ranges were 0.05 to 0.1 pCi/L and 0.2 to 0.5 pCi/L (Fig. 3.54).

3.16.2.3 Established Domestic and Municipal Waters — Seven of the ten Iowa sample sites were municipal or domestic water sources. The concentrations of uranium in these waters ranged from 0.07 to 4 pCi/L and averaged 1.02 pCi/L. The median concentration range was 0.2 to

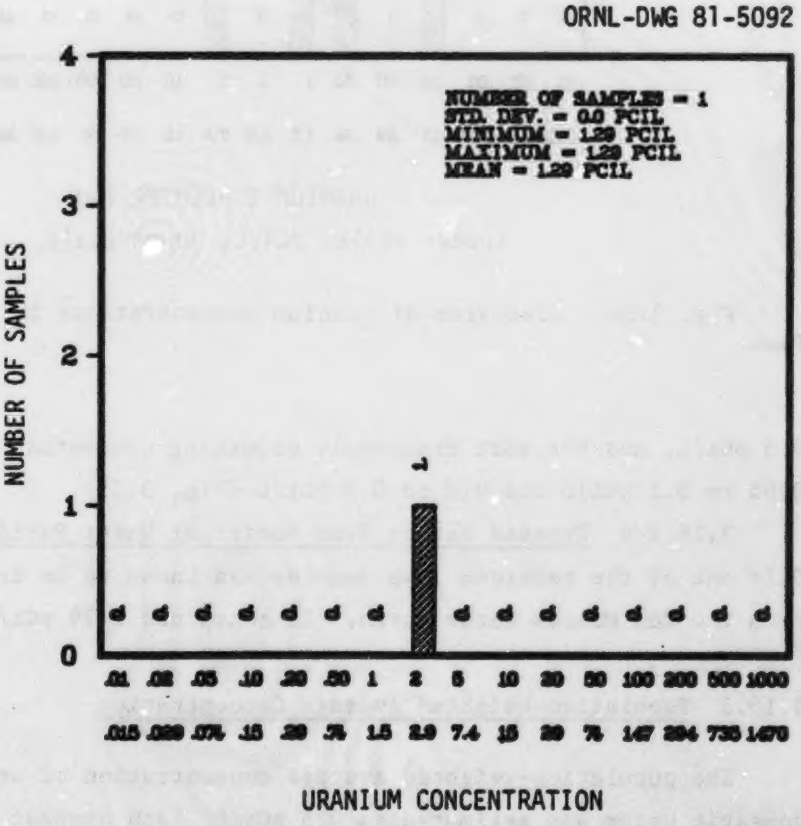


Fig. 3.53. Histogram of uranium concentrations in surface waters of Iowa.

ORNL-DWG 81-5093

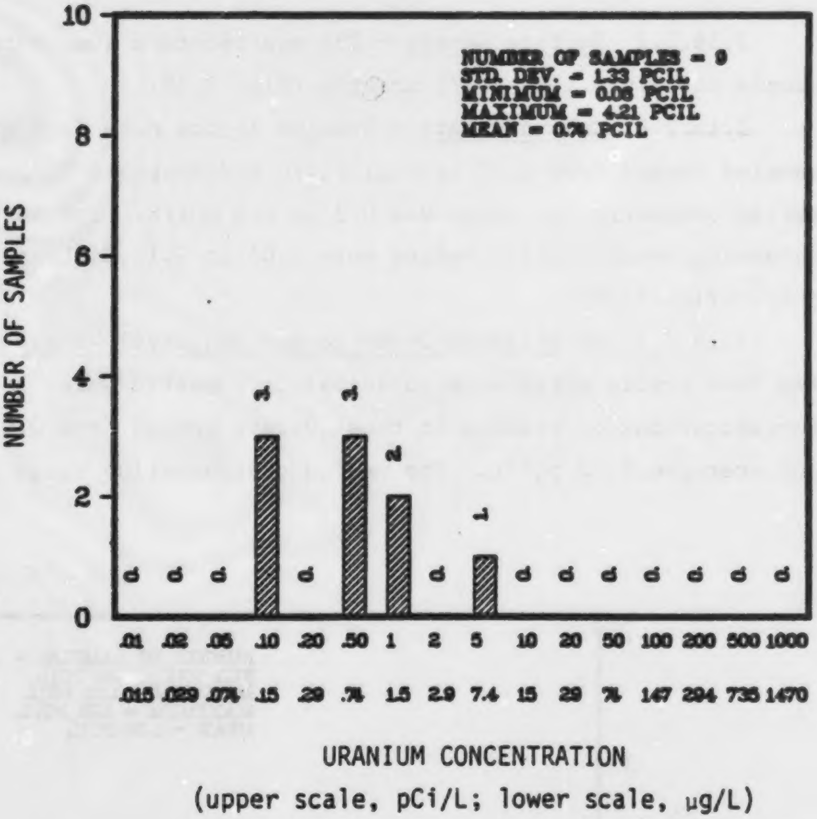


Fig. 3.54. Histogram of uranium concentrations in ground waters of Iowa.

0.5 pCi/L, and the most frequently occurring concentration ranges were 0.05 to 0.1 pCi/L and 0.2 to 0.5 pCi/L (Fig. 3.55).

3.16.2.4 Treated Waters from Municipal Water Purification Plants — Only one of the recorded Iowa samples was known to be treated water, that from the Des Moines Water Works. It contained 1.29 pCi/L uranium.

### 3.16.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Iowa domestic water was estimated as 0.5 pCi/L, 13th highest among all states (Appendix 2). This estimate, like those for Illinois and Idaho, may be

ORNL-DWG 81-5094

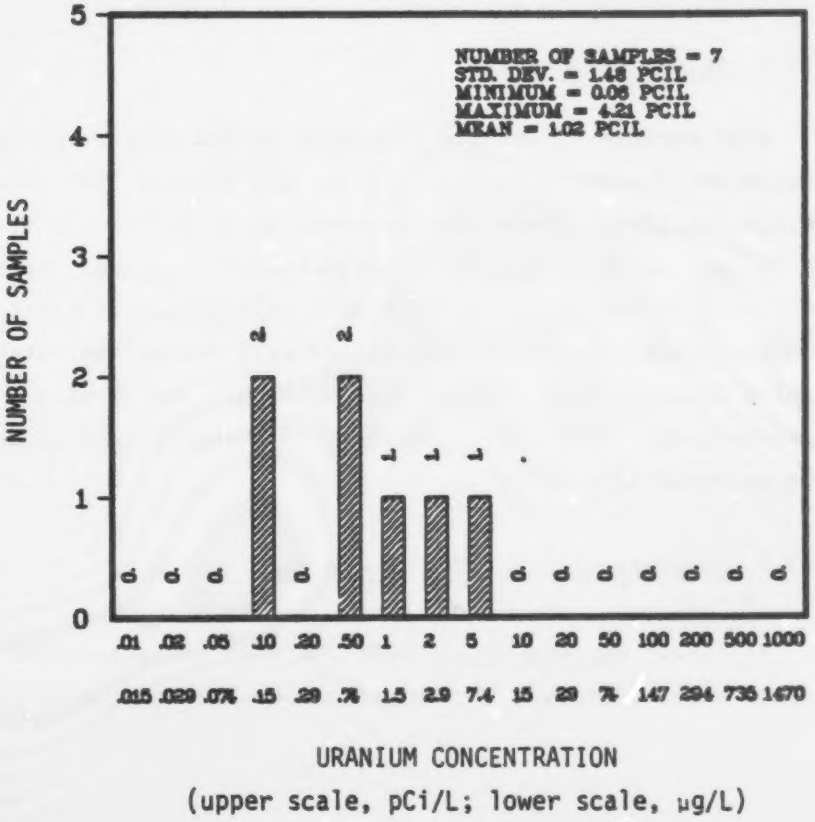


Fig. 3.55. Histogram of uranium concentrations in domestic waters of Iowa.

somewhat high since it is based on the higher-valued modal peak of the Iowa domestic water histogram. The corresponding alpha radiation bone dose was estimated to be 7 mrem/year for Model I and <1 mrem/year for Model II.

### 3.16.4 Water Supplies Exceeding Given Concentrations

From very limited information, we estimate that 26% to 29% of Iowa water supplies have uranium in excess of 1 pCi/L, but that few, if any, have uranium in excess of 5 pCi/L.

## 3.17 URANIUM IN KANSAS WATERS

### 3.17.1 Extent of Coverage

NURE surveys of uranium in Kansas waters have been reported for the Hutchinson, Joplin, Manhattan, Pratt, and Wichita NTMS quadrangles [104, 106,114,116,128]. These surveys cover about 47% of the state's surface and include parts or all of 46 north-central, central, and southern counties. In addition, non-NURE data were available for treated water from the state's three largest cities [26] and for selected ground water samples from 19 sites more or less uniformly distributed throughout the balance of the state [15]. Overall, 2546 surface and ground water sites were surveyed (Fig. 3.56).

### 3.17.2 Concentrations of Uranium in Samples

3.17.2.1 Surface Waters — Of the 2546 sites surveyed, only 28 were surface water sources. The concentrations of uranium in these samples

ORNL-DWG 81-5216

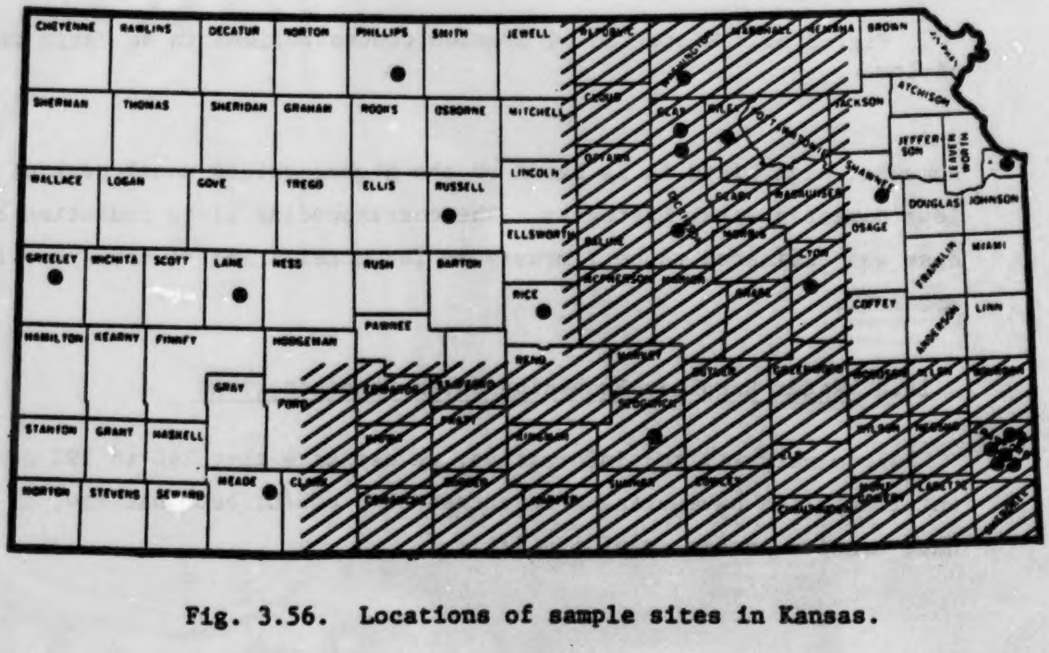

CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
BROWN
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
JACKSON
ATCHISON
JEFFERSON
LEAVENWORTH
WALLACE
LOGAN
GOVE
TREGO
ELLIS
RUSSELL
LINCOLN
DOUGLAS
JOHNSON
ELLSWORTH
OSAGE
MIAMI
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
RICE
FRANKLIN
COFFEY
ANDERSON
LINN
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
GRAY
FORD
STANTON
GRANT
HASKELL
MEADE
CLARK
MORTON
STEVENS
SEWARD

Fig. 3.56. Locations of sample sites in Kansas.

ranged from 0.07 to 187.95 pCi/L and averaged 12.49 pCi/L. The median concentration range was 1 to 2 pCi/L, but the modal concentration range was appreciably lower, 0.05 to 0.1 pCi/L (Fig. 3.57).

3.17.2.2 Ground Waters — Twenty-five hundred eighteen Kansas ground water analyses were located. Uranium in these samples ranged from 0.01 to 120.63 pCi/L and averaged 3.13 pCi/L. The median and modal concentration ranges were 1 to 2 pCi/L and 2 to 5 pCi/L, respectively (Fig. 3.58).

3.17.2.3 Established Domestic and Municipal Waters — Of the Kansas sample sites 1411 were identified as domestic water sources. Uranium in these samples varied from 0.03 to 121 pCi/L and averaged 2.80 pCi/L. The median and modal concentration ranges were 1 to 2 pCi/L (Fig. 3.59).

ORNL-DWG 81-5095

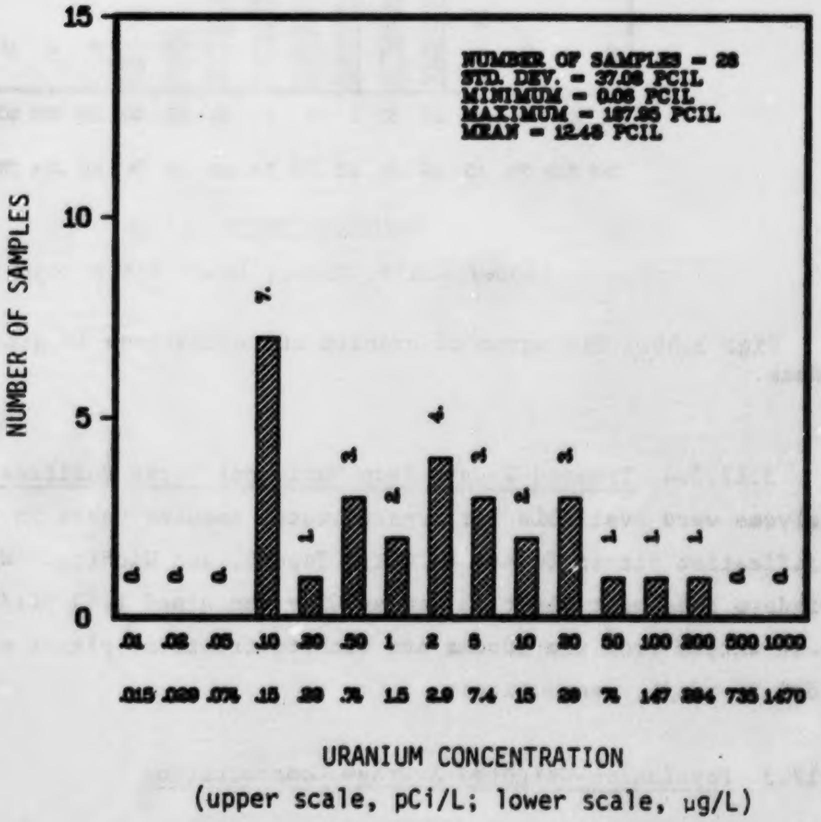


Fig. 3.57. Histogram of uranium concentrations in surface waters of Kansas.

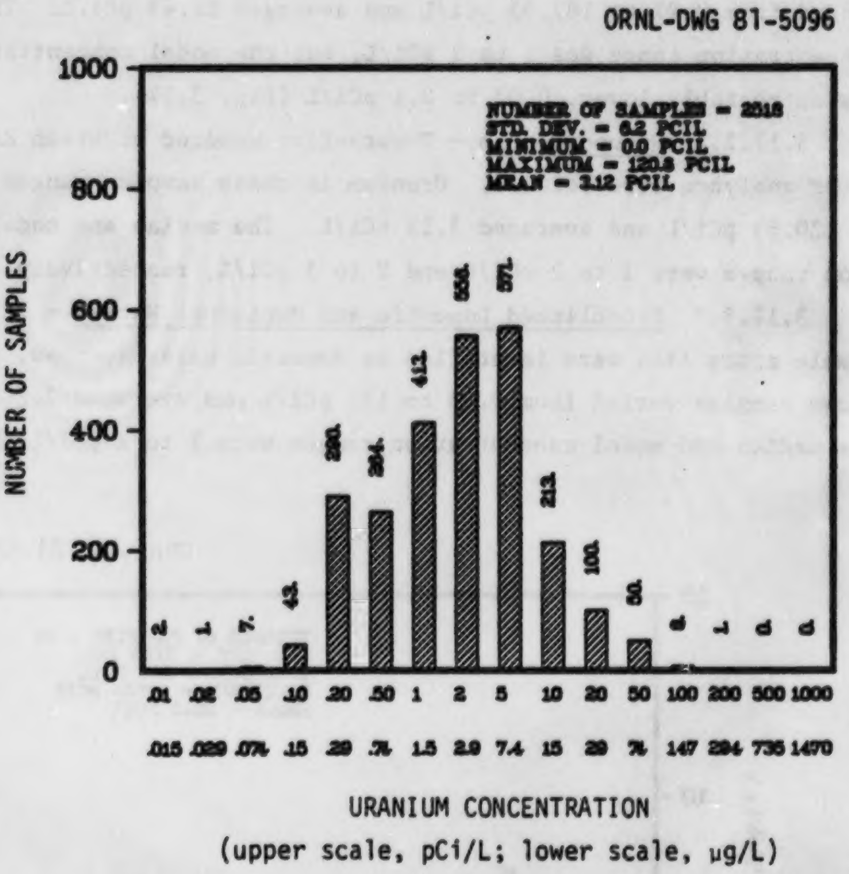


Fig. 3.58. Histogram of uranium concentrations in ground waters of Kansas.

3.17.2.4 Treated Waters from Municipal Water Purification Plants — Analyses were available for treated water samples taken in 1962 from purification plants in Kansas City, Topeka, and Wichita. Water from the Quindaro treatment plant in Kansas City contained 1.63 pCi/L uranium; those waters from the Topeka and Wichita treatment plants contained 0.07 and 0.34 pCi/L, respectively.

### 3.17.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Kansas domestic water was estimated as 1.2 pCi/L (Appendix 2), 9th highest among all states. The corresponding alpha radiation bone dose was estimated to be 18 mrem/year for Model I and <1 mrem/year for Model II.

ORNL-DWG 81-5097

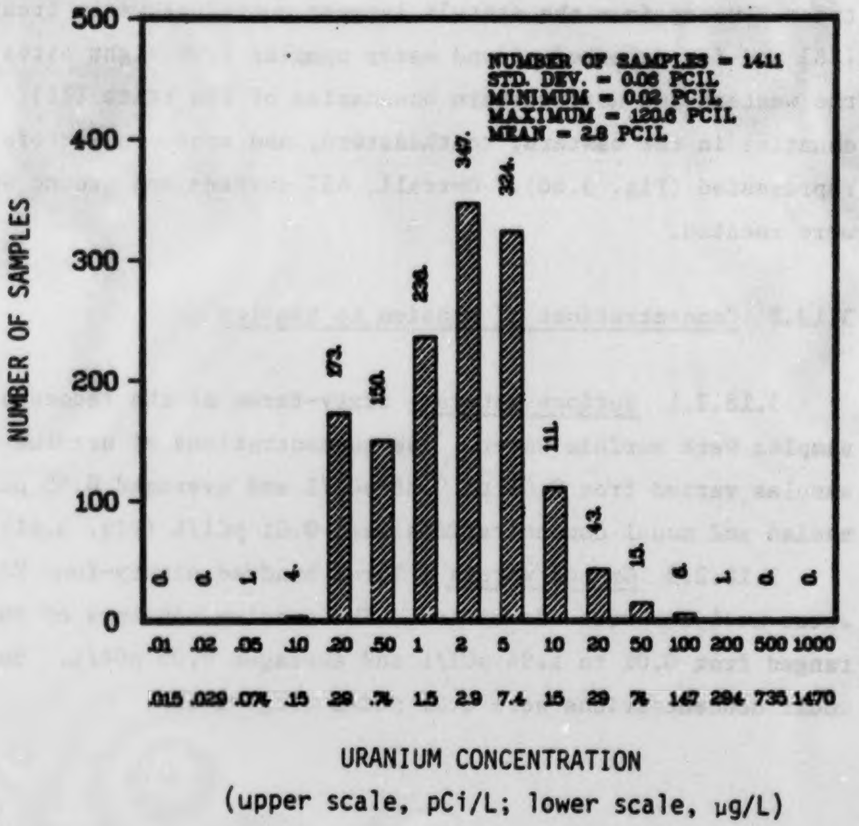


**Fig. 3.59. Histogram of uranium concentrations in domestic waters of Kansas.**

### 3.17.4 Water Supplies Exceeding Given Concentrations

**We estimated that 40% to 60% of Kansas water supplies contain uranium in excess of 1 pCi/L; 0% to 12%, in excess of 5 pCi/L; 0% to 5%, in excess of 10 pCi/L; and 0% to 2%, in excess of 20 pCi/L.**

## 3.18 URANIUM IN KENTUCKY WATERS

### 3.18.1 Extent of Coverage

**NURE analyses were available for only about 5% of the Kentucky waters [83]. This survey included all or parts of ten counties in the**

extreme southwestern corner of the state. Data were also available for treated water from the state's largest municipal water treatment plant [26] and for selected ground water samples from eight sites located near the western and northwestern boundaries of the state [15]. Most of the counties in the eastern, southeastern, and southern sectors were not represented (Fig. 3.60). Overall, 457 surface and ground water analyses were located.

### 3.18.2 Concentrations of Uranium in Samples

3.18.2.1 Surface Waters — Sixty-three of the recorded Kentucky samples were surface water. The concentrations of uranium in these samples varied from 0.01 to 0.86 pCi/L and averaged 0.05 pCi/L. The median and modal concentrations were 0.01 pCi/L (Fig. 3.61).

3.18.2.2 Ground Waters — Three hundred ninety-four Kentucky ground water analyses were identified. The uranium contents of these samples ranged from 0.01 to 1.94 pCi/L and averaged 0.05 pCi/L. Both median and modal concentrations were 0.01 pCi/L (Fig. 3.62).

ORNL-DWG 81-5217

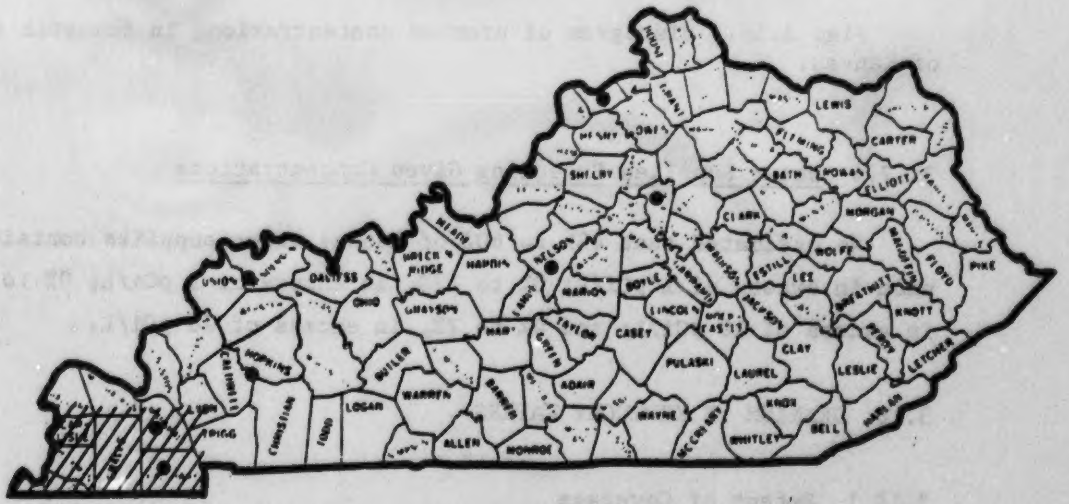

LEWIS
CARTER
FLEMING
ROWAN
ELLIOTT
BATH
SHELBY
CLARK
MORGAN
MAGOFFIN
FLOYD
PIKE
WOLFE
LEE
ESTILL
BREATHITT
KNOTT
PERRY
LETCHER
HARLAN
LESLIE
BELL
CLAY
KNOX
LAUREL
WHITLEY
McCREARY
PULASKI
WAYNE
LINCOLN
CASEY
BOYLE
MARION
TAYLOR
GREEN
ADAIR
NELSON
MEADE
BRECK'N RIDGE
GRAYSON
OHIO
DAVIESS
UNION
HOPKINS
CALDWELL
CHRISTIAN
TODD
LOGAN
BUTLER
WARREN
ALLEN
MONROE
TRIGG

Fig. 3.60. Locations of sample sites in Kentucky.
]

3.18.2.3 Established Domestic and Municipal Waters — Only ten of the recorded Kentucky sample sites were identified as domestic water sources. Among these samples, uranium concentrations varied from 0.07 to 2 pCi/L and averaged 0.53 pCi/L. The modal and median concentration ranges were 0.05 to 0.1 pCi/L and 0.2 to 0.5 pCi/L, respectively (Fig. 3.63).

3.18.2.4 Treated Waters from Municipal Water Purification Plants — Finished water from the Louisville water treatment plant contained 0.27 pCi/L uranium in 1961.

ORNL-DWG 81-5098

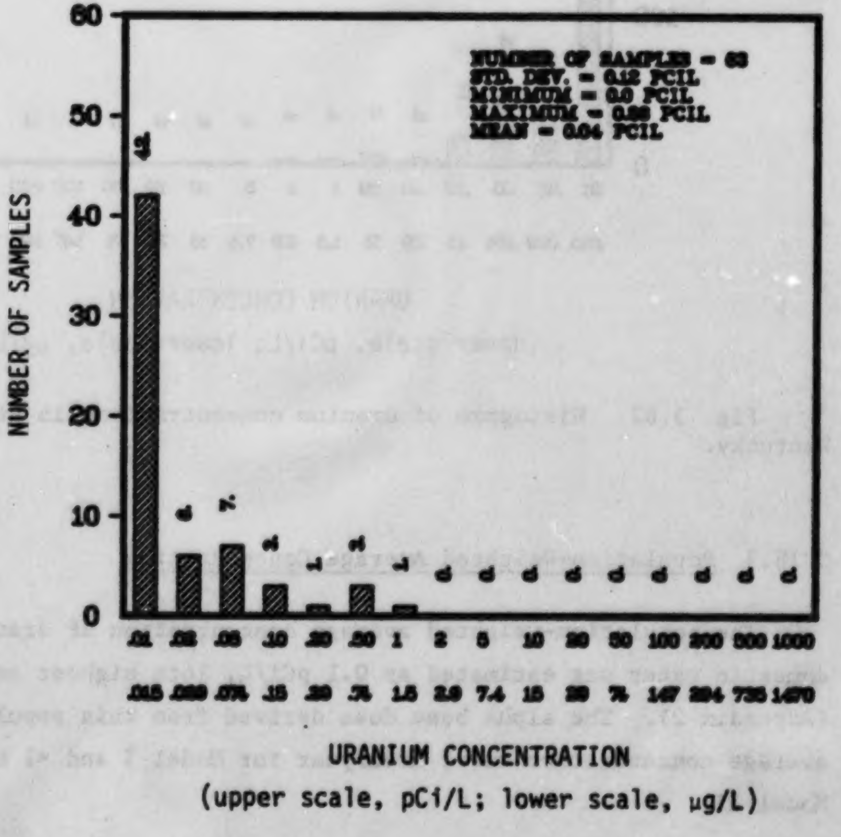


Fig. 3.61. Histogram of uranium concentrations in surface waters of Kentucky.

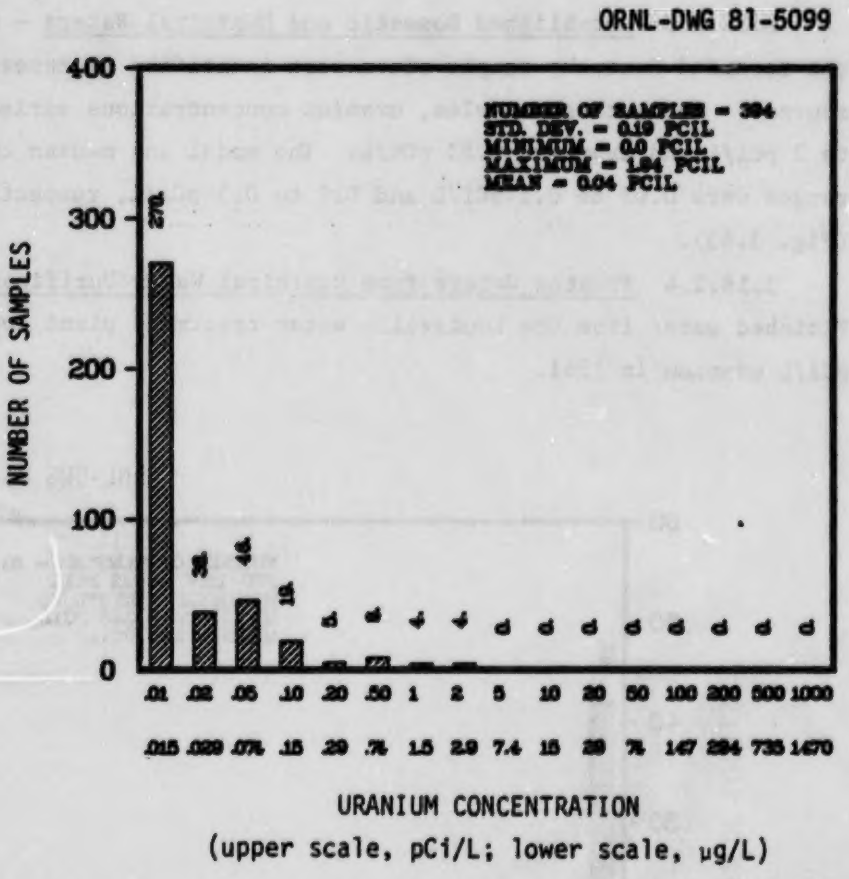


Fig. 3.62. Histogram of uranium concentrations in ground waters of Kentucky.

### 3.18.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Kentucky domestic water was estimated as 0.1 pCi/L, 16th highest among all states (Appendix 2). The alpha bone dose derived from this population-weighted average concentration was 2 mrem/year for Model I and <1 mrem/year for Model II.

### 3.18.4 Water Supplies Exceeding Given Concentrations

We estimated that 20% of Kentucky water supplies have uranium concentrations exceeding 1 pCi/L, but that 0% have uranium concentrations exceeding 5 pCi/L.

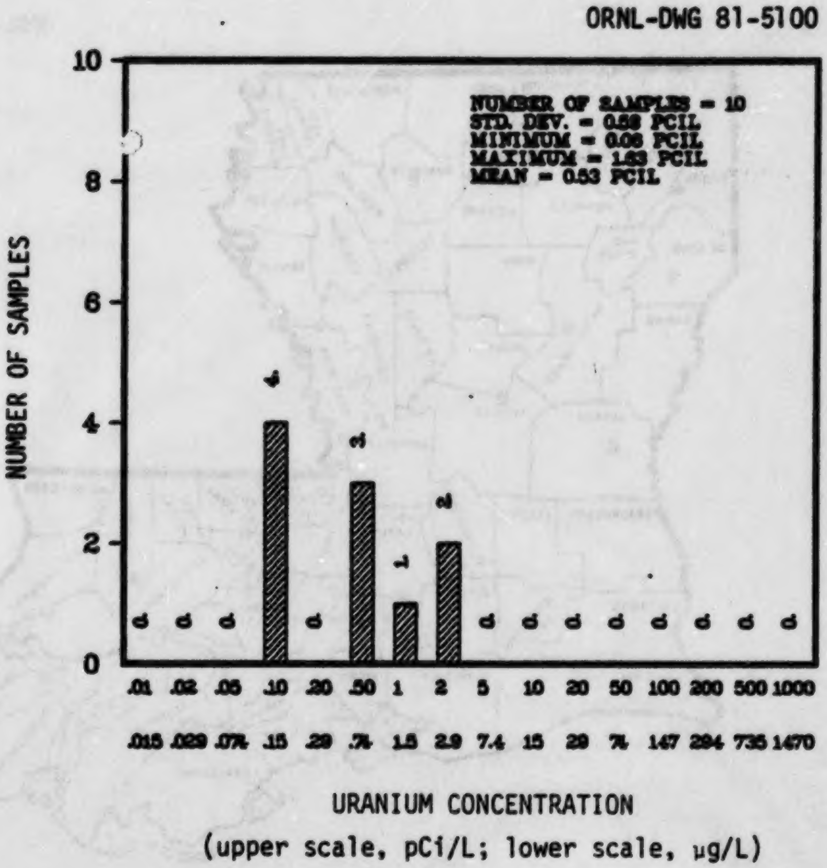


Fig. 3.63. Histogram of uranium concentrations in domestic waters of Kentucky.

## 3.19 URANIUM IN LOUISIANA WATERS

### 3.19.1 Extent of Coverage

Louisiana water sources have not been systematically surveyed for uranium; however, analyses were available for processed waters from treatment plants serving the three largest cities in the state [26] and for ground water samples from eight cities more or less uniformly distributed over the northern sector of the state [15]. Overall, 18 surface and ground water sites were represented (Fig. 3.64).

ORNL-DWG 81-5218

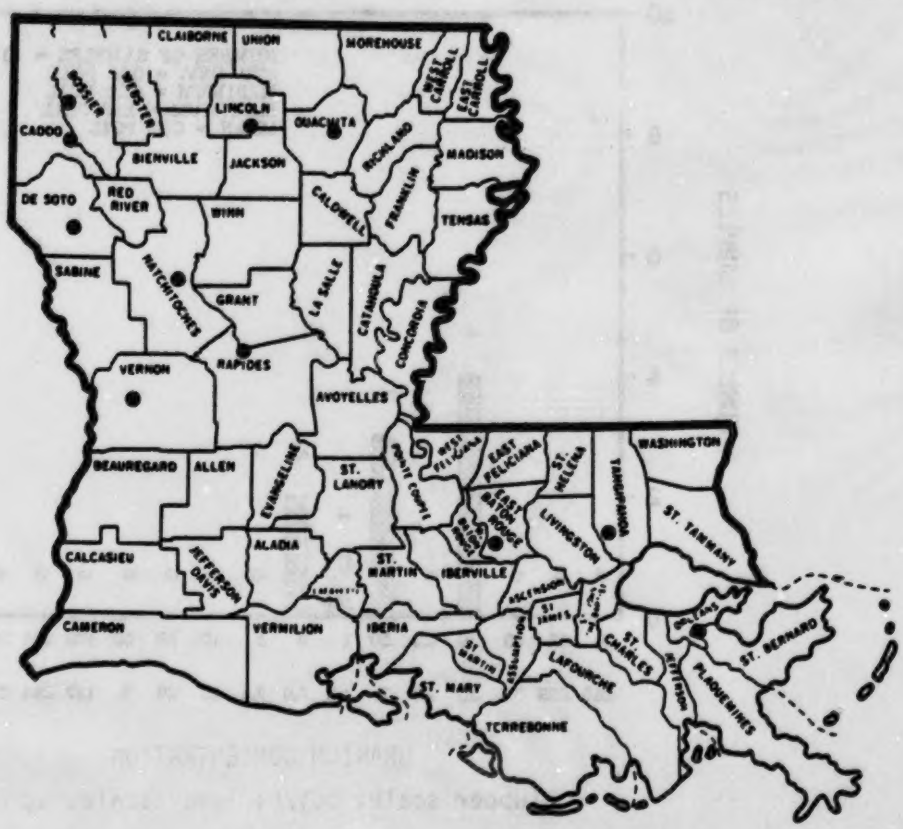

CLAIBORNE
UNION
MOREHOUSE
WEST CARROLL
EAST CARROLL
BOSSIER
WEBSTER
LINCOLN
OUACHITA
CADDO
RICHLAND
MADISON
BIENVILLE
JACKSON
CALDWELL
FRANKLIN
DE SOTO
RED RIVER
WINN
TENSAS
SABINE
NATCHITOCHES
GRANT
LA SALLE
CATAHOULA
CONCORDIA
VERNON
RAPIDES
AVOYELLES
BEAUREGARD
ALLEN
EVANGELINE
ST. LANDRY
POINTE COUPEE
WEST FELICIANA
EAST FELICIANA
ST. HELENA
TANGIPAHOA
WASHINGTON
EAST BATON ROUGE
LIVINGSTON
ST. TAMMANY
CALCASIEU
JEFFERSON DAVIS
ACADIA
ST. MARTIN
IBERVILLE
ASCENSION
ST. JAMES
CAMERON
VERMILION
IBERIA
ST. MARTIN
ASSUMPTION
LAFOURCHE
ST. CHARLES
JEFFERSON
PLAQUEMINES
ST. BERNARD
ST. MARY
TERREBONNE

Fig. 3.64. Locations of sample sites in Louisiana.

### 3.19.2 Concentrations of Uranium in Samples

3.19.2.1 Surface Waters — None of the four Louisiana surface water samples contained appreciable quantities of uranium; the range was 0.07 to 0.13 pCi/L, the mean was 0.09 pCi/L, and the median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.65).

3.19.2.2 Ground Waters — Fourteen of the Louisiana samples were ground water. The concentrations of uranium in these samples varied from 0.07 to 0.34 pCi/L and averaged 0.10 pCi/L. The modal and median concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.66).

3.19.2.3 Established Domestic and Municipal Waters — All of the sample sites listed for Louisiana were identified as domestic or municipal sources. Analyses of water from these sites ranged from 0.07 to

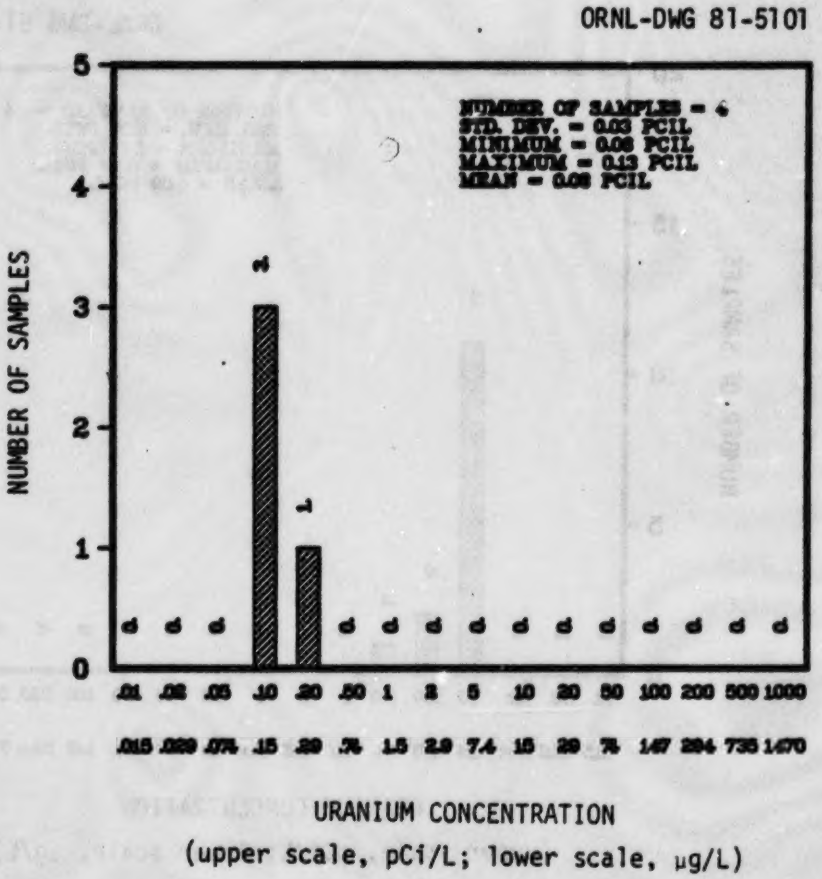


Fig. 3.65. Histogram of uranium concentrations in surface waters of Louisiana.

0.34 pCi/L uranium and averaged 0.09 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.67).

3.19.2.4 Treated Waters from Municipal Water Purification Plants — Eight of the recorded samples were identified as treated water from municipal water purification plants; each was sampled in 1961 or 1962. All facilities of the Baton Rouge water system (Lula Street, Lafayette Street, Government Street, and Bankston Street plants) and the Shreveport water system (Cross Lake and McNeill Street plants) produced finished water containing less than 0.07 pCi/L uranium. In New Orleans, water from the Algiers and Carrollton purification plants contained 0.14 and <0.07 pCi/L uranium, respectively.

ORNL-DWG 81-5102

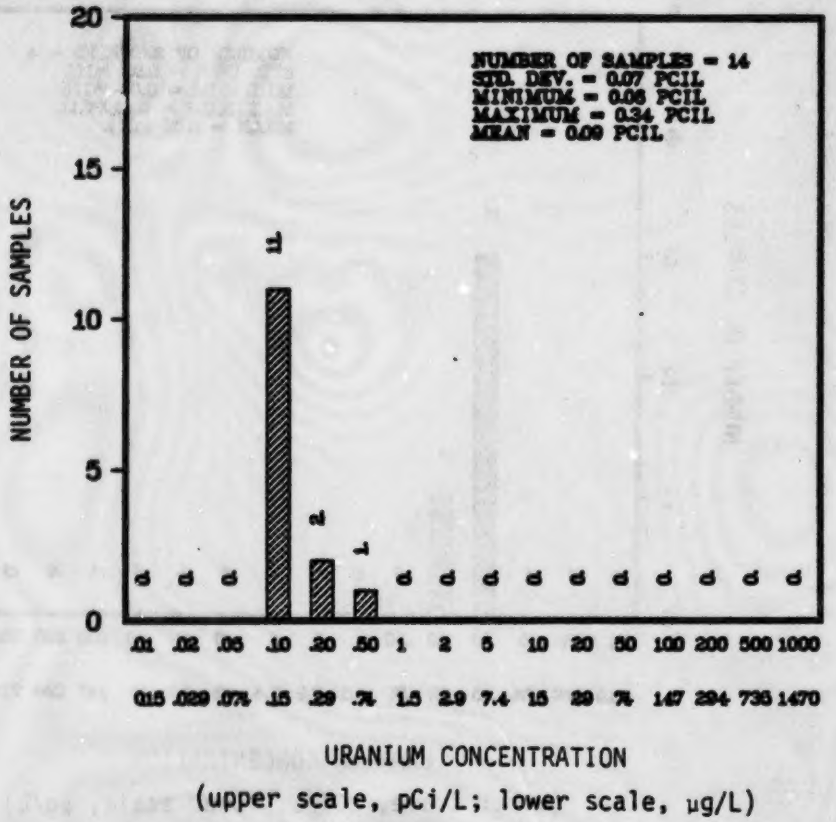


Fig. 3.66. Histogram of uranium concentrations in ground waters of Louisiana.

### 3.19.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Louisiana domestic water was estimated as <0.1 pCi/L, the lowest rating among all states (Appendix 2). The corresponding alpha radiation bone dose was estimated as 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.19.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% of Louisiana water supplies have uranium concentrations exceeding 1 pCi/L.

ORNL-DWG 81-5103

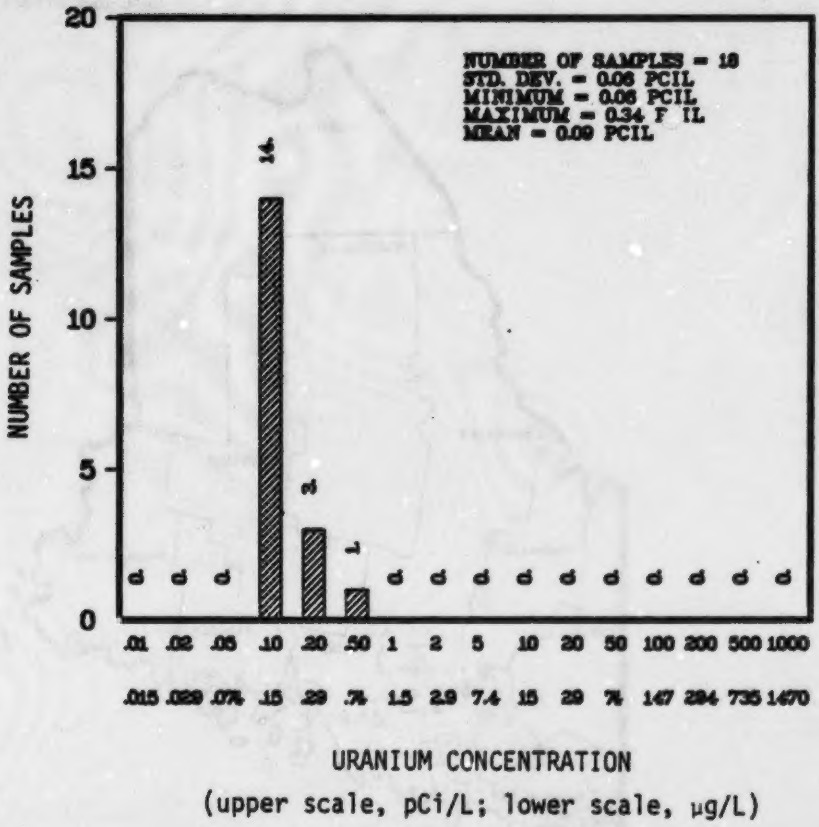


Fig. 3.67. Histogram of uranium concentrations in domestic waters of Louisiana.

## 3.20 URANIUM IN MAINE WATERS

### 3.20.1 Extent of Coverage

Only the southern tip of Maine lying within the Portland NTMS quadrangle has been systematically surveyed for uranium in water [72]. This area corresponds to York and parts of Cumberland, Oxford, and Androscoggin counties, altogether about 10% of the state's area. A few additional selected samples were available, mostly in Kennebec and Androscoggin counties [15]. Overall, 604 surface and ground water sites were represented (Fig. 3.68).

ORNL-DWG 81-5219

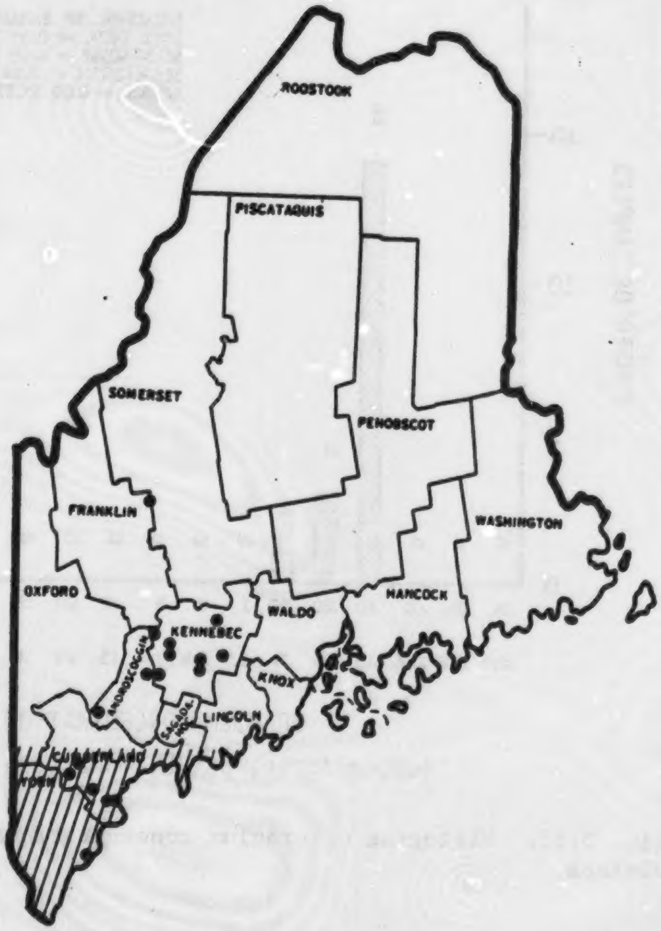

AROOSTOOK
PISCATAQUIS
SOMERSET
PENOBSCOT
FRANKLIN
WASHINGTON
OXFORD
KENNEBEC
WALDO
HANCOCK
ANDROSCOGGIN
KNOX
SAGADAHOC
LINCOLN
CUMBERLAND
YORK

Fig. 3.68. Locations of sample sites in Maine.

### 3.20.2 Concentrations of Uranium in Samples

3.20.2.1 Surface Waters — Four hundred four surface water analyses were located. Uranium in these samples ranged from 0.01 to 2.65 pCi/L and averaged 0.05 pCi/L. The median concentration range was 0.02 to 0.05 pCi/L. The most frequently occurring concentration was 0.01 pCi/L (Fig. 3.69).

3.20.2.2 Ground Waters — Two hundred Maine ground water analyses were found. Uranium in these samples varied from 0.01 to 652.80 pCi/L

ORNL-DWG 81-5104

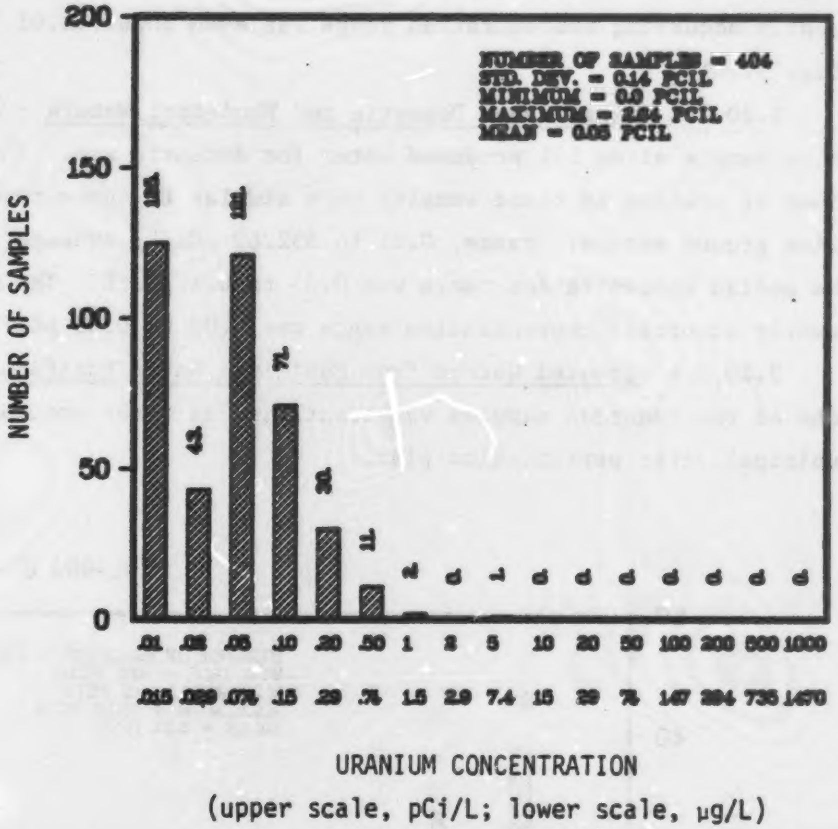


**Fig. 3.69. Histogram of uranium concentrations in surface waters of Maine.**

**and averaged 5.36 pCi/L. This high average value was due to the occurrence of three samples that analyzed well in excess of 100 pCi/L uranium. These samples were analyzed in 1958 using techniques less refined than those currently available, but there is no doubt that these samples contained high concentrations of uranium. No obvious sources of contamination of these samples were reported. According to Koller [72] there appears to be no uranium mineralization in the Maine portion of the Portland quadrangle; nevertheless, the presence of nearby uraniferous deposits is probably the best available explanation for these exceptional samples. The infrequent occurrence of such samples suggests that uraniferous deposits are highly localized in Maine. The median concentration**

range for Maine ground waters was 0.1 to 0.2 pCi/L, and the most frequently occurring concentration range was even lower, 0.02 to 0.05 pCi/L (Fig. 3.70).

3.20.2.3 Established Domestic and Municipal Waters — Of the 604 Maine sample sites 191 produced water for domestic use. The concentrations of uranium in these samples were similar to those reported for Maine ground waters: range, 0.01 to 652.80 pCi/L; average, 5.60 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L. The most frequently occurring concentration range was 0.02 to 0.05 pCi/L (Fig. 3.71).

3.20.2.4 Treated Waters from Municipal Water Purification Plants — None of the recorded samples was identified as water processed in a municipal water purification plant.

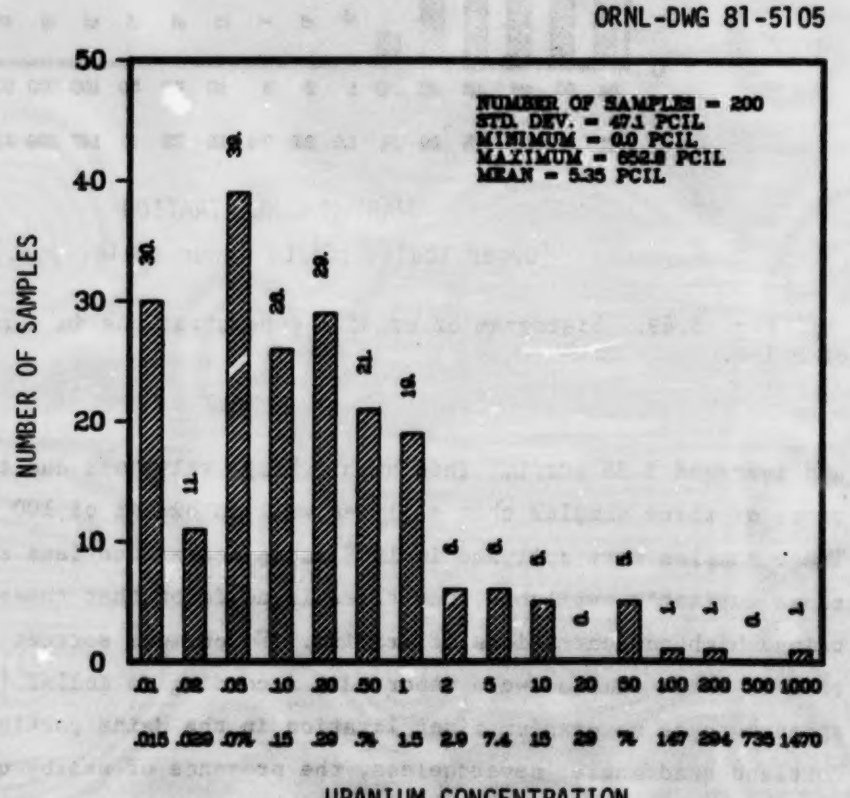


Fig. 3.70. Histogram of uranium concentrations in ground waters of Maine.

ORNL-DWG 81-5106

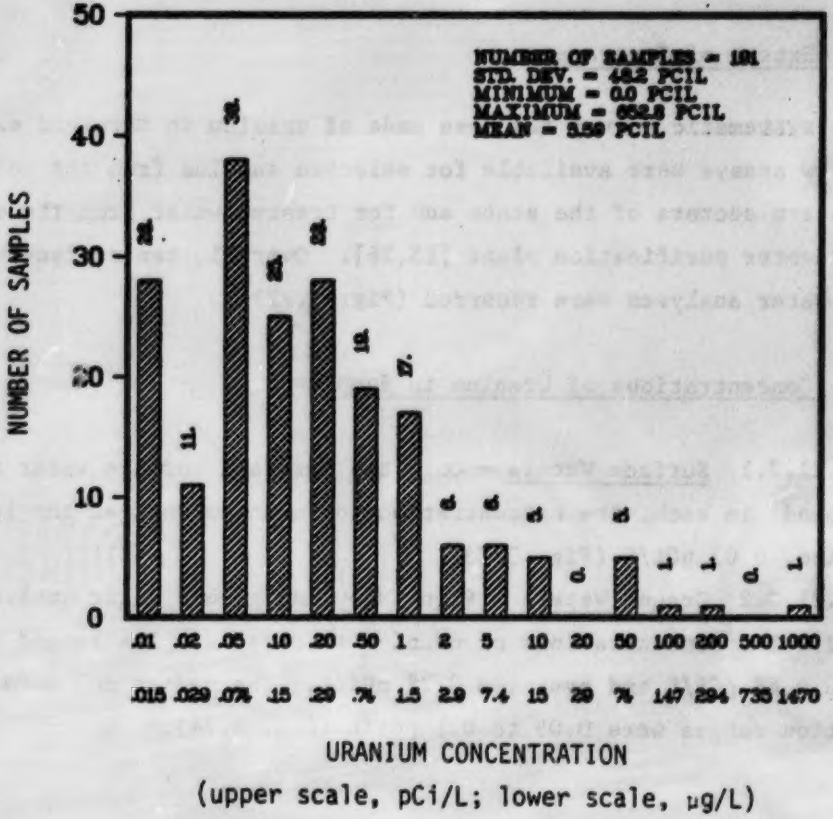


**Fig. 3.71. Histogram of uranium concentrations in domestic waters of Maine.**

### 3.20.3 Population-Weighted Average Concentration

**The population-weighted average concentration of uranium in Maine domestic waters was estimated as 0.2 pCi/L, 15th highest among all states (Appendix 2). Based on this average, the estimated alpha radiation bone dose was 3 mrem/year for Model I and <1 mrem/year for Model II.**

### 3.20.4 Water Supplies Exceeding Given Concentrations

**We estimated that 0% to 13% of Maine water supplies contain uranium in excess of 1 pCi/L; 0% to 7%, in excess of 5 pCi/L; 0% to 4% in excess of 10 pCi/L; and 0% to 4% in excess of 20%.**

## 3.21 URANIUM IN MARYLAND WATERS

### 3.21.1 Extent of Coverage

No systematic survey has been made of uranium in Maryland waters, but a few assays were available for selected samples from the northern and eastern sectors of the state and for treated water from the state's largest water purification plant [15,26]. Overall, ten surface and ground water analyses were recorded (Fig. 3.72).

### 3.21.2 Concentrations of Uranium in Samples

3.21.2.1 Surface Waters — Only two Maryland surface water analyses were found; in each, the concentrations of uranium were at the limit of detection, 0.07 pCi/L (Fig. 3.73).

3.21.2.2 Ground Waters — Eight Maryland ground water analyses were located. The concentrations of uranium in these samples ranged from 0.07 to 0.68 pCi/L and averaged 0.28 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.74).

ORNL-DWG 81-5220

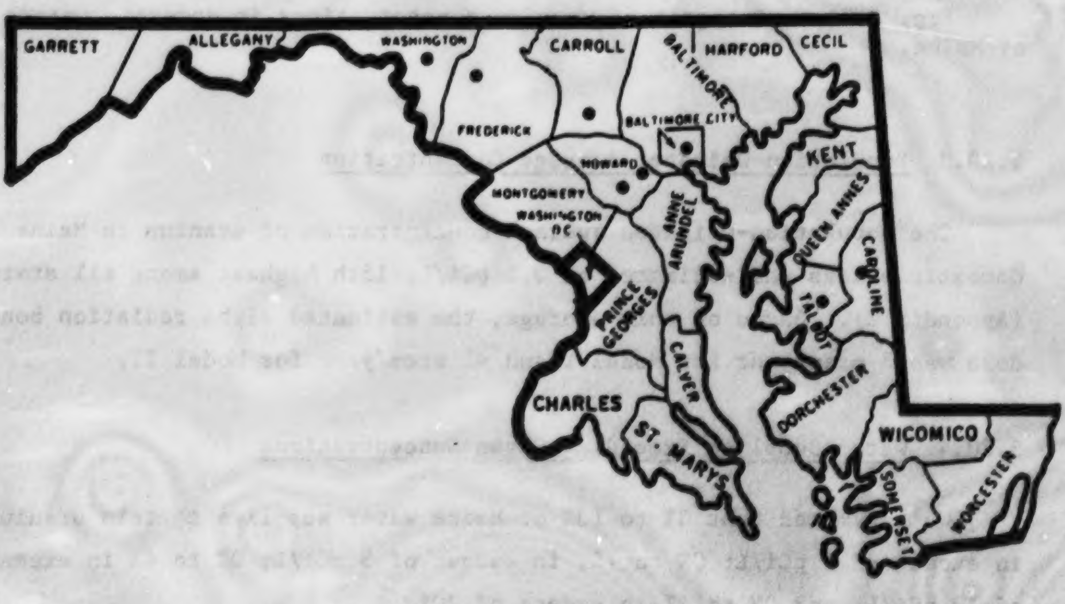

GARRETT
ALLEGANY
WASHINGTON
CARROLL
BALTIMORE
HARFORD
CECIL
BALTIMORE CITY
FREDERICK
HOWARD
KENT
MONTGOMERY
WASHINGTON DC
ANNE ARUNDEL
QUEEN ANNES
CAROLINE
TALBOT
PRINCE GEORGES
CALVER
DORCHESTER
CHARLES
ST. MARYS
WICOMICO
SOMERSET
WORCESTER

Fig. 3.72. Locations of sample sites in Maryland.

ORNL-DWG 81-5107

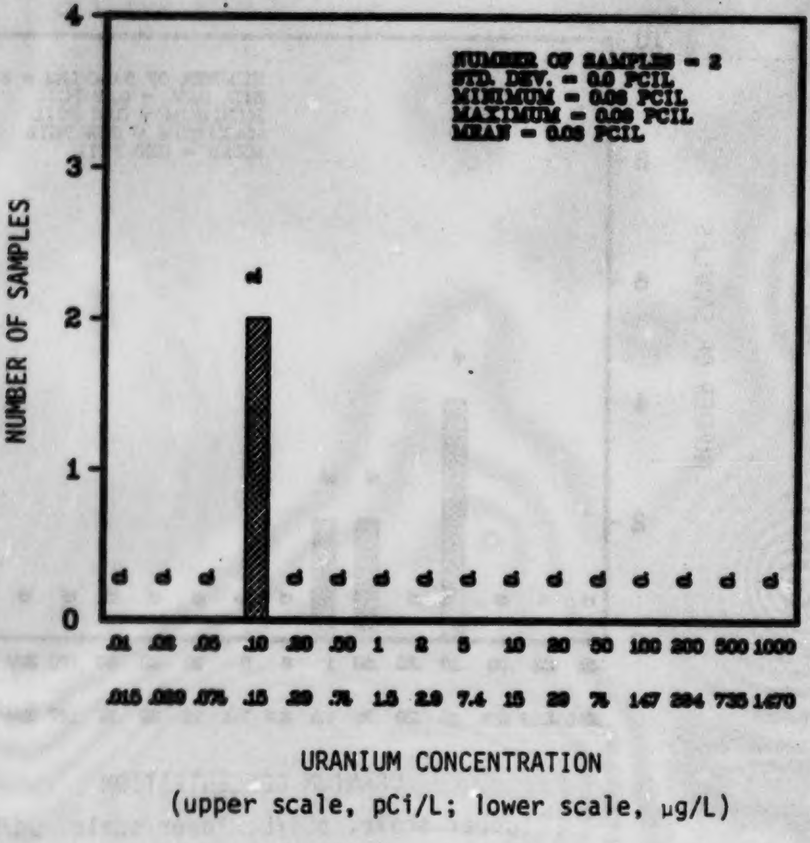


Fig. 3.73. Histogram of uranium concentrations in surface waters of Maryland.

3.21.2.3 Established Domestic and Municipal Waters — Nine of the Maryland sites produced water for domestic consumption. The concentrations of uranium in these waters ranged from 0.07 to 0.68 pCi/L and averaged 0.21 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.75).

3.21.2.4 Treated Waters from Municipal Water Purification Plants — Water from the Montebello and Ashburton filtration plants in Baltimore contained <0.07 pCi/L uranium.

### 3.21.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Maryland domestic waters was estimated as <0.1 pCi/L, ranking Maryland 17th highest

ORNL-DWG 81-5108

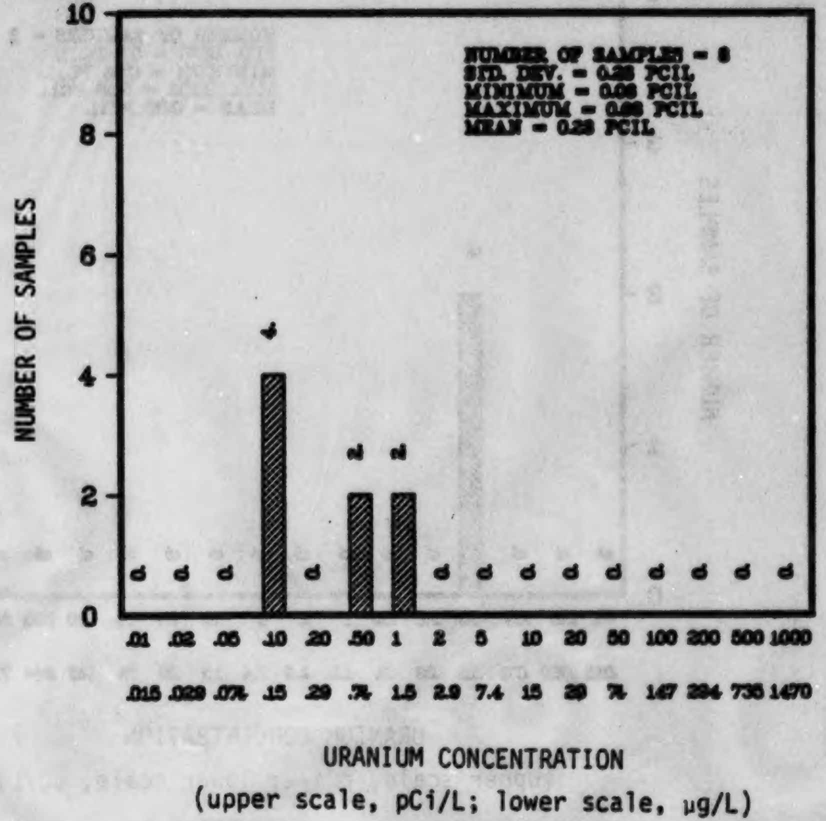


**Fig. 3.74. Histogram of uranium concentrations in ground waters of Maryland.**

**among all states (Appendix 2). From this value the alpha radiation bone dose for Model I and II was estimated as 1 mrem/year and <1 mrem/year, respectively.**

### 3.21.4 Water Supplies Exceeding Given Concentrations

**On the basis of the limited information available, we estimated that 0% of Maryland water supplies contain uranium in excess of 1 pCi/L.**

ORNL-DWG 81-5109

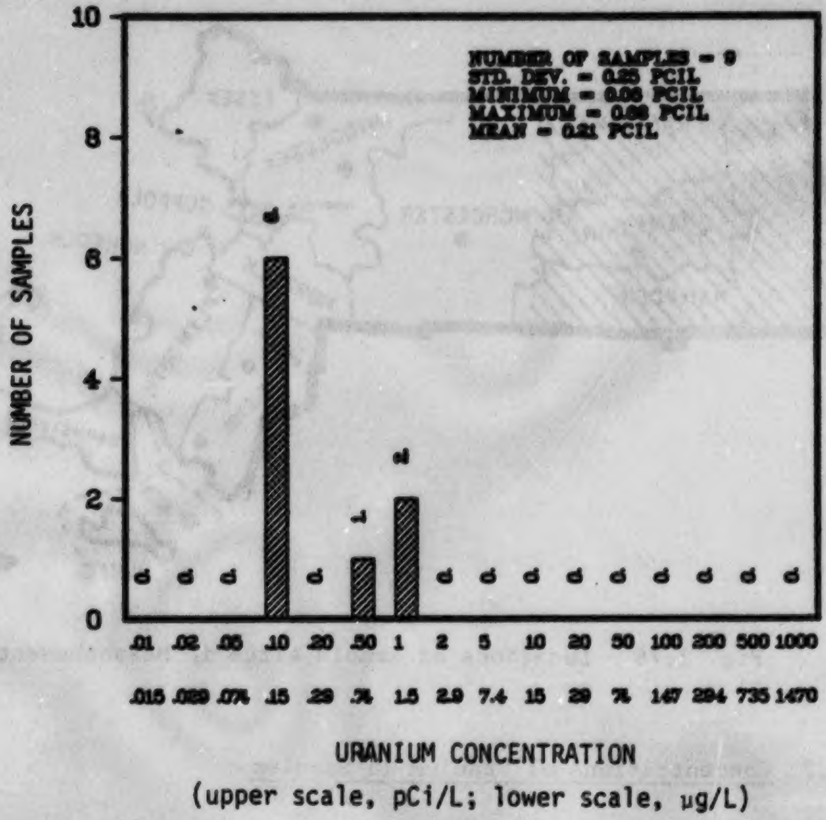


Fig. 3.75. Histogram of uranium concentrations in domestic waters of Maryland.

## 3.22 URANIUM IN MASSACHUSETTS WATERS

### 3.22.1 Extent of Coverage

NURE data were available for a little less than half of Massachusetts [82]. This study included all of Berkshire, Franklin, Hampden, and Hampshire counties, as well as the western quarter of Worchester. In addition, selected analyses were available for water from sites more or less uniformly distributed over the rest of the state [15] (Fig. 3.76). Data were also obtained for treated waters from the state's three largest cities [26]. Overall, 960 surface and ground water sites were sampled.

ORNL-DWG 81-5221

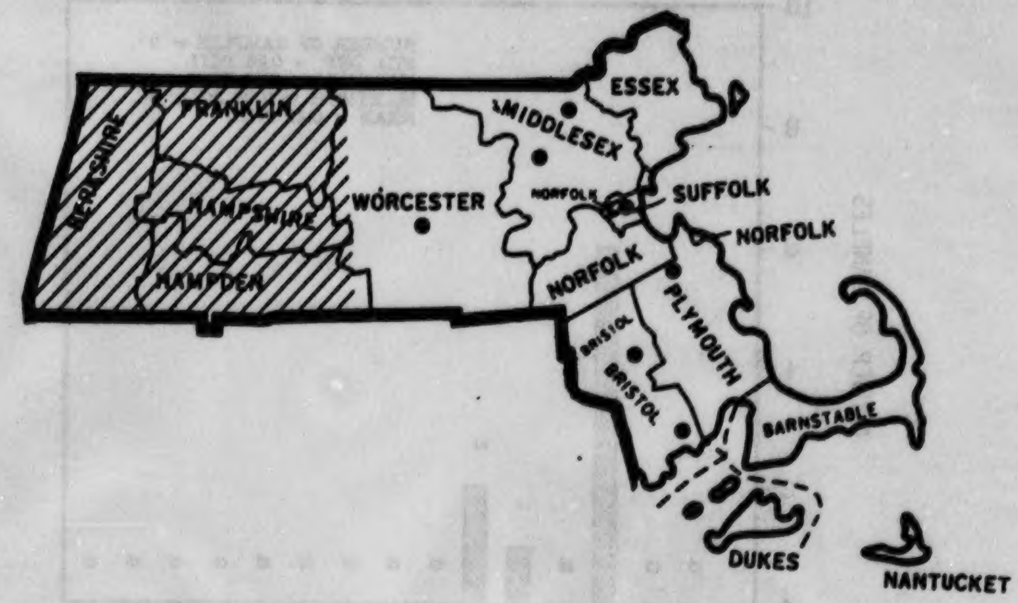

BERKSHIRE
FRANKLIN
HAMPSHIRE
HAMPDEN
WORCESTER
MIDDLESEX
ESSEX
NORFOLK
SUFFOLK
NORFOLK
NORFOLK
PLYMOUTH
BRISTOL
BRISTOL
BARNSTABLE
DUKES
NANTUCKET

Fig. 3.76. Locations of sample sites in Massachusetts.

### 3.22.2 Concentrations of Uranium in Samples

3.22.2.1 Surface Waters — Six hundred thirty-nine surface water samples were identified. The concentrations of uranium in these waters ranged from 0.01 to 12.49 pCi/L and averaged 0.12 pCi/L. The median and modal concentrations were 0.01 pCi/L (Fig. 3.77).

3.22.2.2 Ground Waters — There were 321 ground water samples available from Massachusetts. The concentrations of uranium in these samples varied from 0.01 to 14.84 pCi/L and averaged 0.34 pCi/L. The median concentration range for this subset was 0.02 to 0.05, but the mode was only 0.01 pCi/L (Fig. 3.78).

3.22.2.3 Established Domestic and Municipal Waters — Of the 960 Massachusetts sample sites, 308 were identified as domestic water sources. Uranium in these waters varied from 0.01 to 15 pCi/L and averaged 0.34 pCi/L. The median concentration range was 0.02 to 0.05 pCi/L, but the most frequently occurring concentration was 0.01 pCi/L (Fig. 3.79).

ORNL-DWG 81-5110

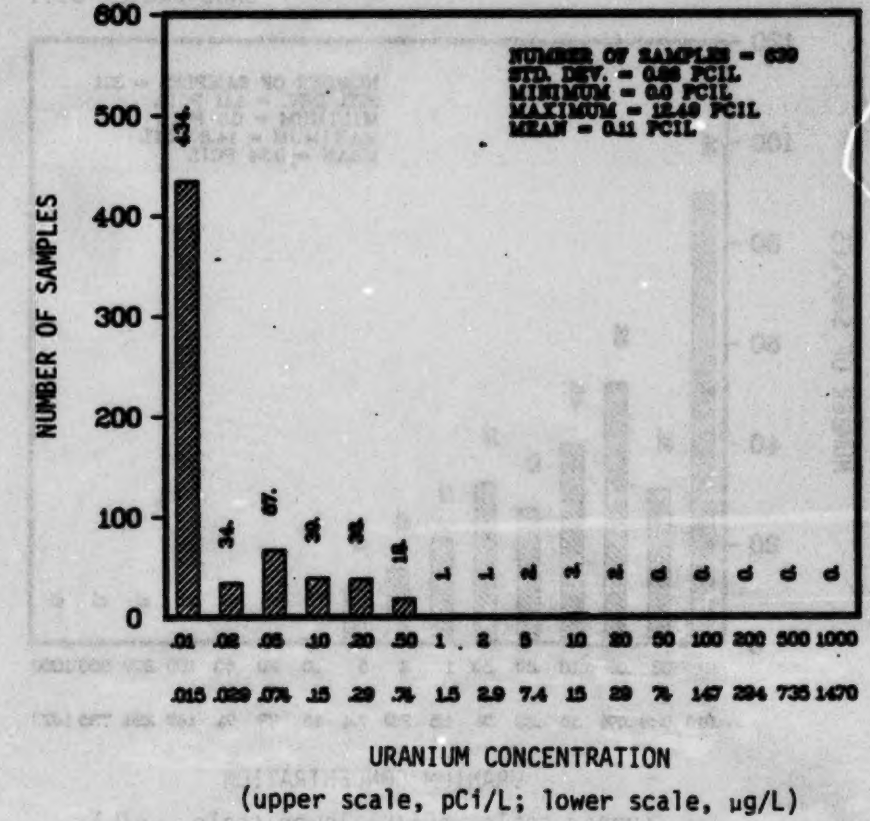


Fig. 3.77. Histogram of uranium concentrations in surface waters of Massachusetts.

3.22.2.4 Treated Waters from Municipal Water Purification Plants — The concentrations of uranium in treated waters from water purification plants in Boston, Springfield, and Worcester were <0.07 pCi/L in 1962.

### 3.22.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Massachusetts domestic waters was estimated as <0.1 pCi/L, 17th highest among all states (Appendix 2). Based on this value, the alpha radiation bone dose was estimated as <1 mrem/year for Models I and II.

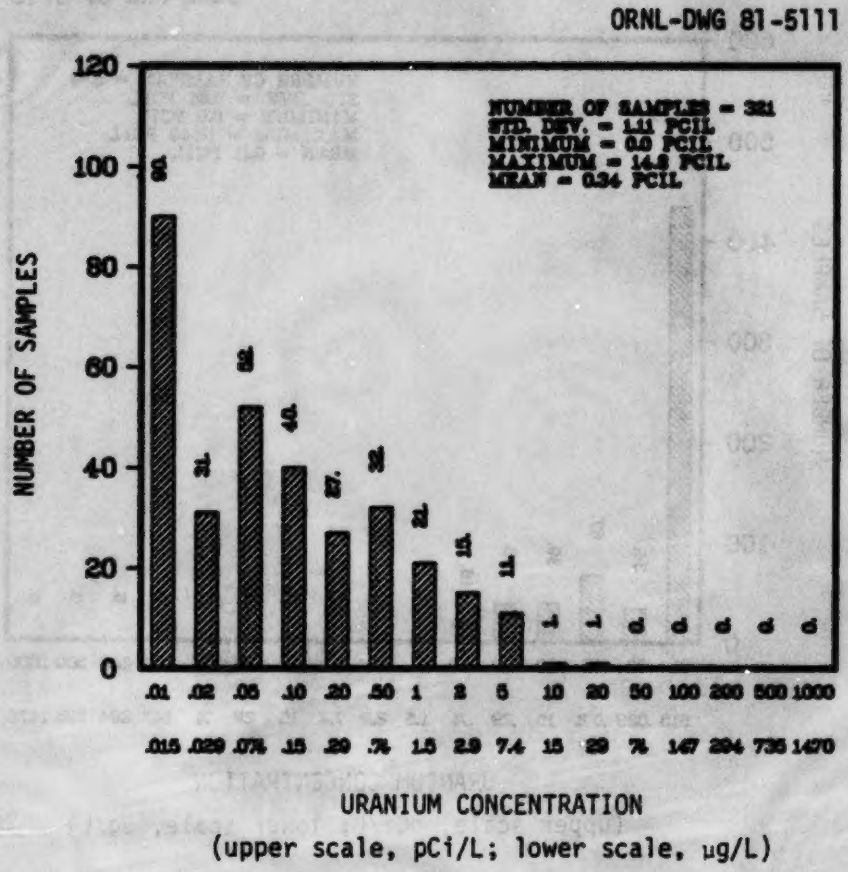


**Fig. 3.78. Histogram of uranium concentrations in ground waters of Massachusetts.**

### 3.22.4 Water Supplies Exceeding Given Concentrations

**We estimated that 0% to 8% of Massachusetts water supplies contain uranium in excess of 1 pCi/L; 0% to 0.6%, in excess of 5 pCi/L; 0% to 0.3%, in excess of 10 pCi/L; and 0% in excess of 20 pCi/L.**

## 3.23 URANIUM IN MICHIGAN WATERS

### 3.23.1 Extent of Coverage

**NURE surveys of uranium in Michigan waters have been reported only for the western tip of Gogebic County [99] and the southwestern corner**

ORNL-DWG 81-5112

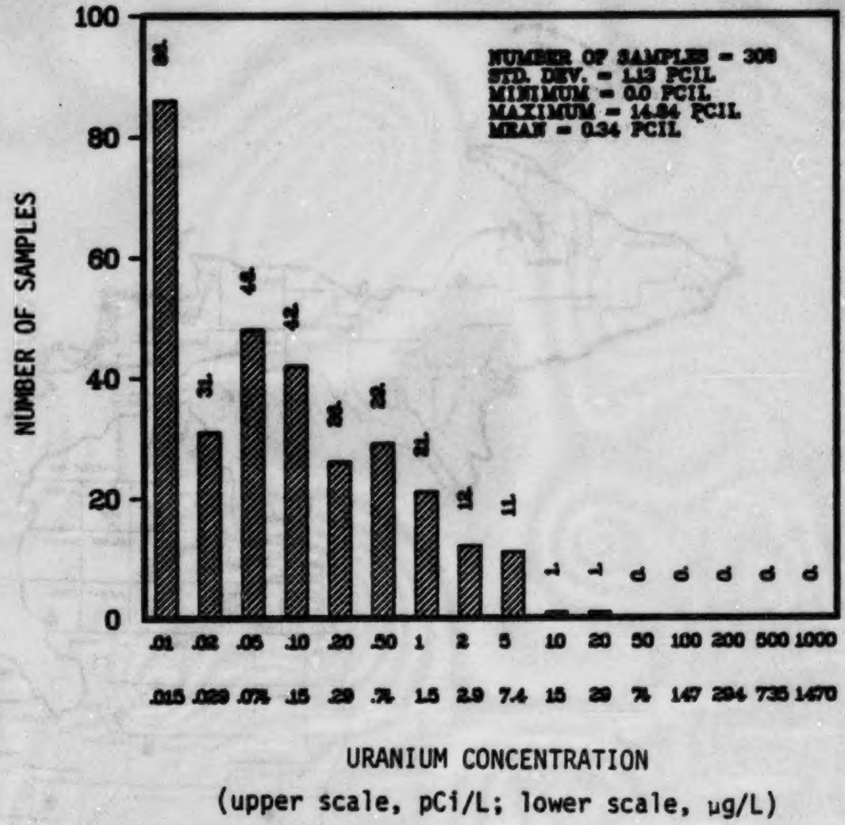


Fig. 3.79. Histogram of uranium concentrations in domestic waters of Massachusetts.

of Dickinson County [13]. These locations account for approximately 1% of the total area of the state. Fortunately, other analyses were available for several sites on the upper peninsula, for selected cities in the southeastern sector [15], and for treated waters from the three largest cities [26]. In all, some 54 surface and ground water sites were sampled (Fig. 3.80).

### 3.23.2 Concentrations of Uranium in Samples

3.23.2.1 Surface Waters — The concentrations of uranium in 11 listed surface waters ranged from 0.01 to 0.70 pCi/L and averaged 0.17

ORNL-DWG 81-5222

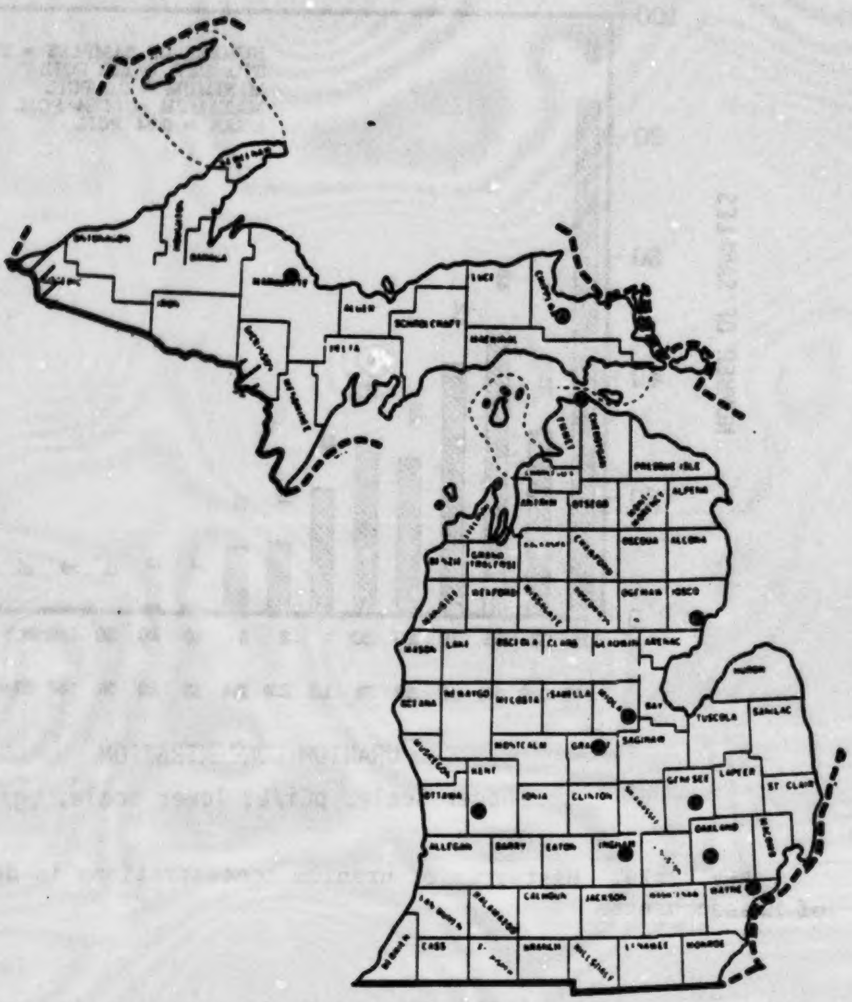

LUCE
ALGER
SCHOOLCRAFT
DELTA
MACKINAC
CHEBOYGAN
EMMET
PRESQUE ISLE
ANTRIM
OTSEGO
ALPENA
CRAWFORD
OSCODA
ALCONA
GRAND TRAVERSE
WEXFORD
OGEMAW
IOSCO
MASON
LAKE
OSCEOLA
CLARE
ARENAC
HURON
OCEANA
NEWAYGO
MECOSTA
ISABELLA
BAY
TUSCOLA
SANILAC
MONTCALM
SAGINAW
MUSKEGON
KENT
GENESEE
LAPEER
OTTAWA
IONIA
CLINTON
ST CLAIR
OAKLAND
ALLEGAN
BARRY
EATON
INGHAM
CALHOUN
JACKSON
WAYNE
KALAMAZOO
CASS
BRANCH
HILLSDALE
MONROE

Fig. 3.80. Locations of sample sites in Michigan.

pCi/L. The median and modal concentration ranges were 0.1 to 0.2 pCi/L (Fig. 3.81).

3.23.2.2 Ground Waters — Data were obtained for 43 Michigan ground water sites. The concentrations of uranium in these waters ranged from 0.01 to 67.99 pCi/L and averaged 3.27 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.82).

3.23.2.3 Established Domestic and Municipal Waters — Thirty-nine of the Michigan sites were identified as domestic water sources. Uranium in

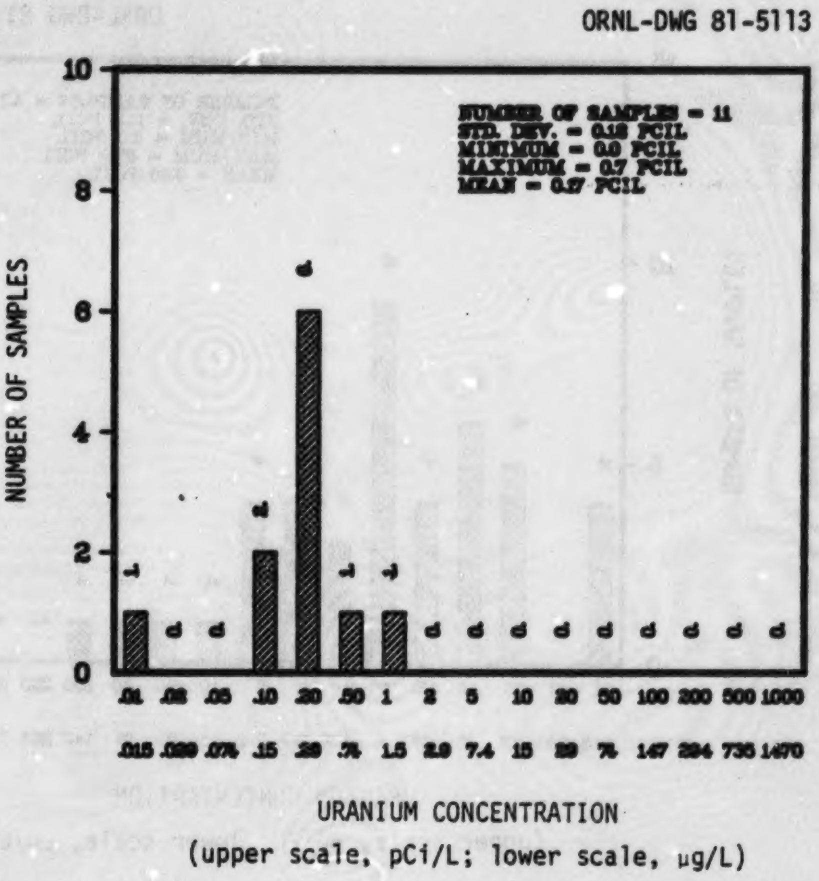


Fig. 3.81. Histogram of uranium concentrations in surface waters of Michigan.

these waters ranged from 0.01 to 68 pCi/L and averaged 3.23 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.83).

3.23.2.4 Treated Waters from Municipal Water Purification Plants — In 1961 the concentrations of uranium in treated waters from the Detroit, Flint, and Grand Rapids municipal water systems were 0.07, 0.07, and 0.14 pCi/L, respectively [26].

### 3.23.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Michigan domestic water was estimated as 0.2 pCi/L, 15th highest among all states

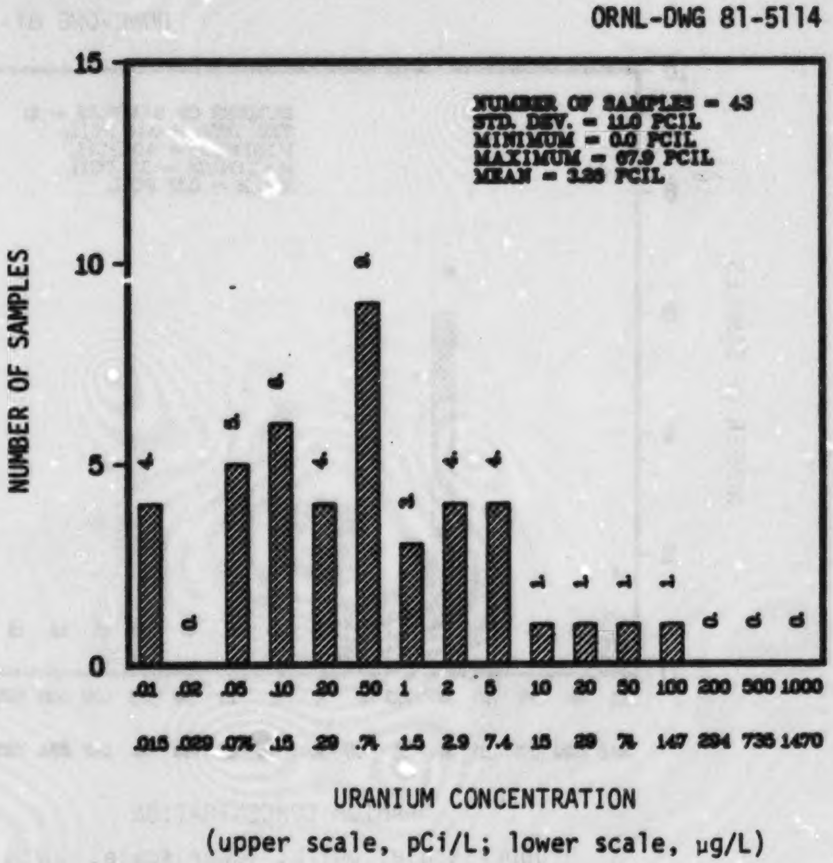


**Fig. 3.82. Histogram of uranium concentrations in ground waters of Michigan.**

**(Appendix 2). The corresponding alpha radiation bone dose was 3 mrem/year for Model I and <1 mrem/year for Model II.**

### 3.23.4. Water Supplies Exceeding Given Concentrations

**We estimated that 0% to 28% of Michigan water supplies contain uranium in excess of 1 pCi/L; 0% to 8%, in excess of 5 pCi/L; 0% to 5%, in excess of 10 pCi/L; and 0% to 5%, in excess of 20 pCi/L.**

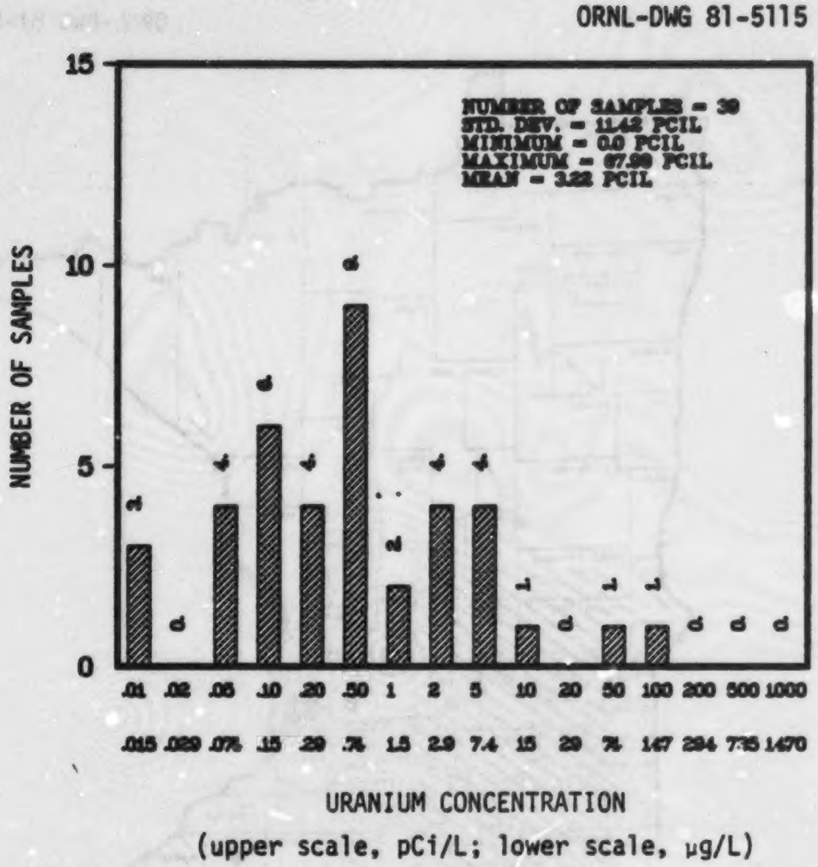


Fig. 3.83. Histogram of uranium concentrations in domestic waters of Michigan.

## 3.24 URANIUM IN MINNESOTA WATERS

### 3.24.1 Extent of Coverage

Data were available from NURE surveys of the St. Cloud, New Ulm, Ashland, and Eau Claire NTMS quadrangles [99,115,125,127]. These areas represent about 16% of the state's surface and mainly cover parts or all of 28 counties in the southwestern corner of the state. In addition, uranium analyses were found for water from several small towns in the southern part of the state [15] and for treated water from Minneapolis and St. Paul [26]. In all, 1466 surface and ground water sites were surveyed (Fig. 3.84).

ORNL-DWG 81-5223

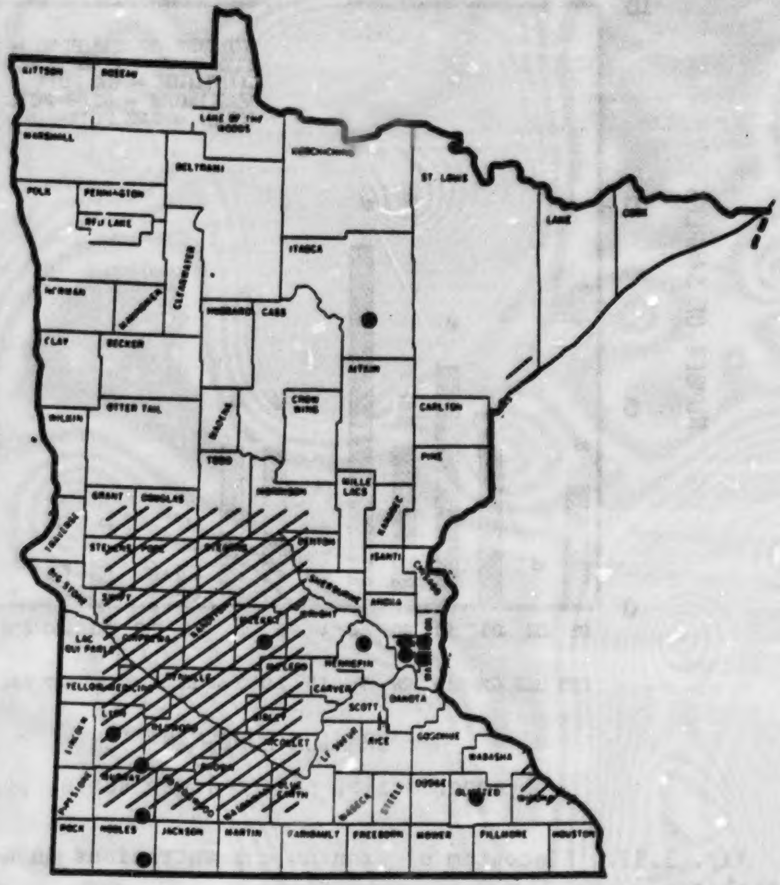

KITTSON
ROSEAU
LAKE OF THE WOODS
MARSHALL
BELTRAMI
KOOCHICHING
ST. LOUIS
LAKE
COOK
POLK
PENNINGTON
RED LAKE
CLEARWATER
ITASCA
NORMAN
MAHNOMEN
HUBBARD
CASS
CLAY
BECKER
AITKIN
WILKIN
OTTER TAIL
WADENA
CROW WING
CARLTON
PINE
TODD
GRANT
DOUGLAS
MORRISON
MILLE LACS
KANABEC
TRAVERSE
STEVENS
POPE
STEARNS
BENTON
ISANTI
CHISAGO
BIG STONE
SWIFT
SHERBURNE
ANOKA
KANDIYOHI
MEEKER
WRIGHT
LAC QUI PARLE
CHIPPEWA
HENNEPIN
RENVILLE
MCLEOD
CARVER
YELLOW MEDICINE
SCOTT
DAKOTA
LINCOLN
LYON
REDWOOD
SIBLEY
NICOLLET
LE SUEUR
RICE
GOODHUE
WABASHA
PIPESTONE
MURRAY
COTTONWOOD
BROWN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON

Fig. 3.84. Locations of sample sites in Minnesota.

### 3.24.2 Concentrations of Uranium in Samples

3.24.2.1 Surface Waters — Uranium in 18 Minnesota surface water samples ranged from 0.07 to 0.55 pCi/L and averaged 0.36 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.85).

3.24.2.2 Ground Waters — Fourteen hundred forty-eight Minnesota ground water samples were located. Uranium in this subset ranged from 0.01 to 67.99 pCi/L and averaged 1.88 pCi/L. The modal and median concentration ranges were 0.1 to 0.2 pCi/L and 0.2 to 0.5 pCi/L, respectively (Fig. 3.86).

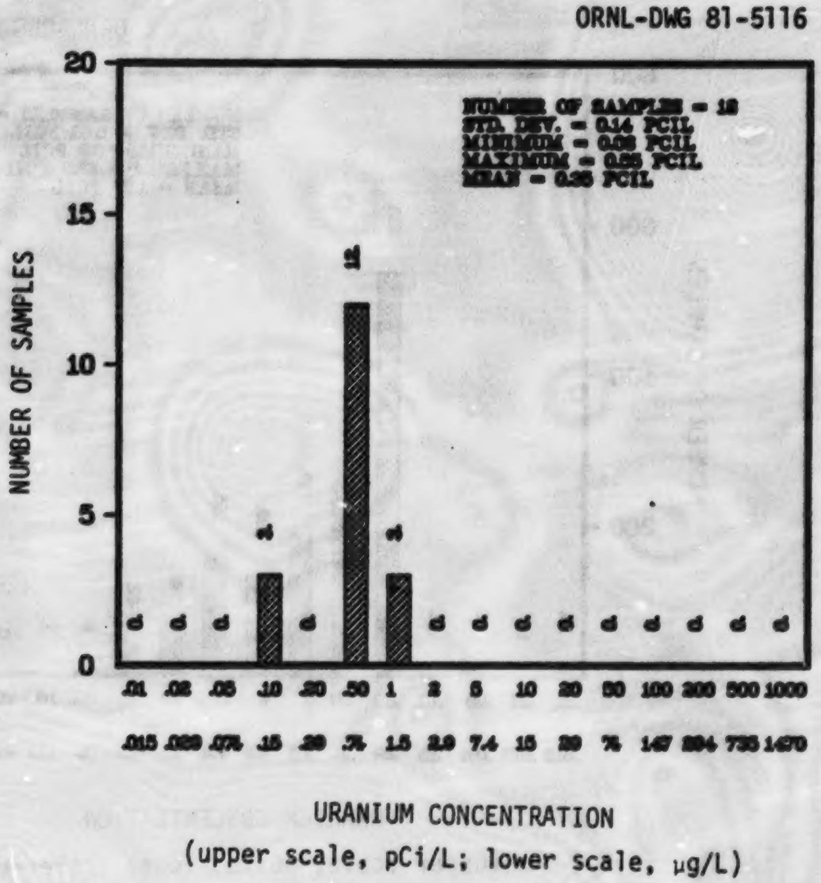


Fig. 3.85. Histogram of uranium concentrations in surface waters of Minnesota.

3.24.2.3 Established Domestic and Municipal Waters — Most of the Minnesota water sites (1351) were identified as domestic water sources. The concentrations of uranium in these waters ranged from 0.01 to 68 pCi/L and averaged 1.91 pCi/L. The most common concentration range was 0.1 to 0.2 pCi/L; the median concentration range was 0.2 to 0.5 pCi/L (Fig. 3.87).

3.24.2.4 Treated Waters from Municipal Water Purification Plants — In 1961 treated water from the Fridley and Columbia Heights filtration plants in Minneapolis and from the McCarron purification plant in St. Paul contained 0.07 pCi/L uranium.

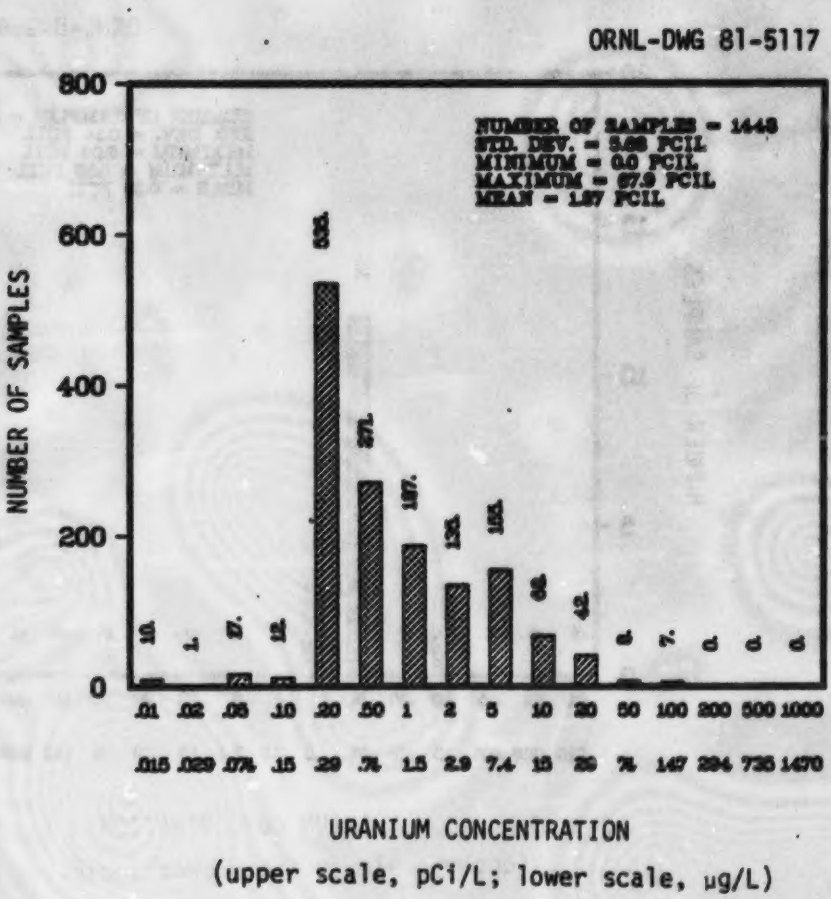


Fig. 3.86. Histogram of uranium concentrations in ground waters of Minnesota.

### 3.24.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Minnesota domestic water was estimated as 0.2 pCi/L, 15th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 2 mrem/year for Model I and <1 mrem/year for Model II.

### 3.24.4 Water Supplies Exceeding Given Concentrations

We estimated 14% to 29% of Minnesota water supplies contain uranium in excess of 1 pCi/L; 0% to 9%, in excess of 5 pCi/L; 0% to 4%, in excess of 10 pCi/L; and 0% to 1%, in excess of 20 pCi/L.

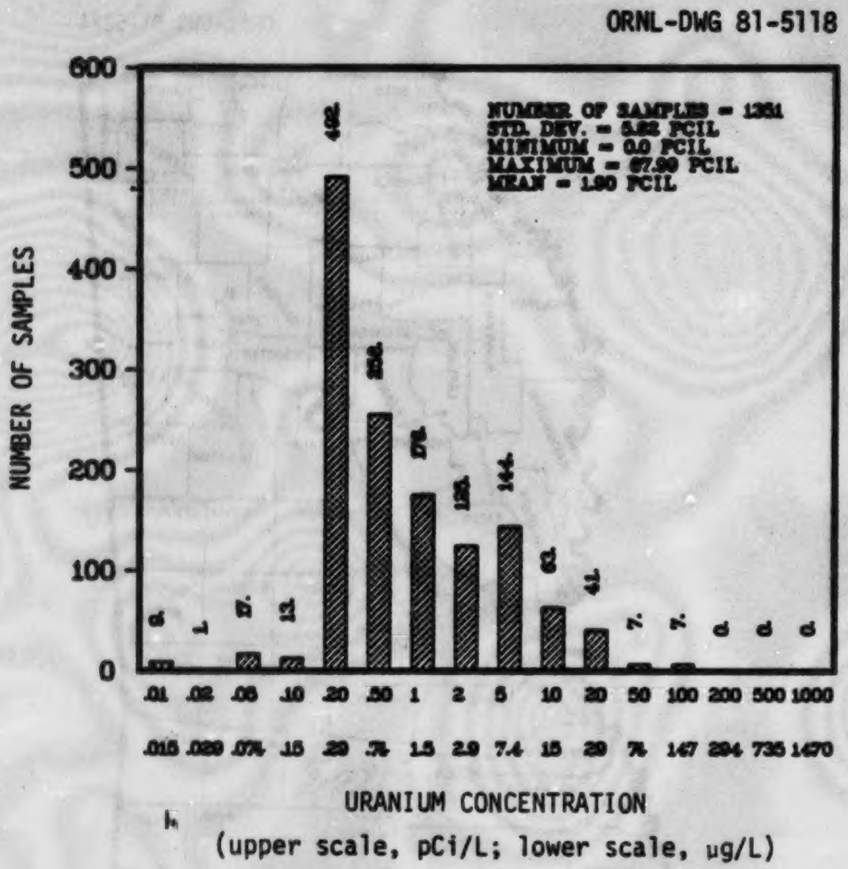


Fig. 3.87. Histogram of uranium concentrations in domestic waters of Minnesota.

## 3.25 URANIUM IN MISSISSIPPI WATERS

### 3.25.1 Extent of Coverage

Only a few Mississippi water sources have been analyzed for uranium. One of these was the municipal water treatment plant for the state's largest city, Jackson [26]. In addition, analyses were available for water from six county seats [15]. Fortunately, the latter water sources were dispersed more or less uniformly throughout the state (Fig. 3.88). Overall, seven surface and ground water sites were represented.

ORNL-DWG 81-5224

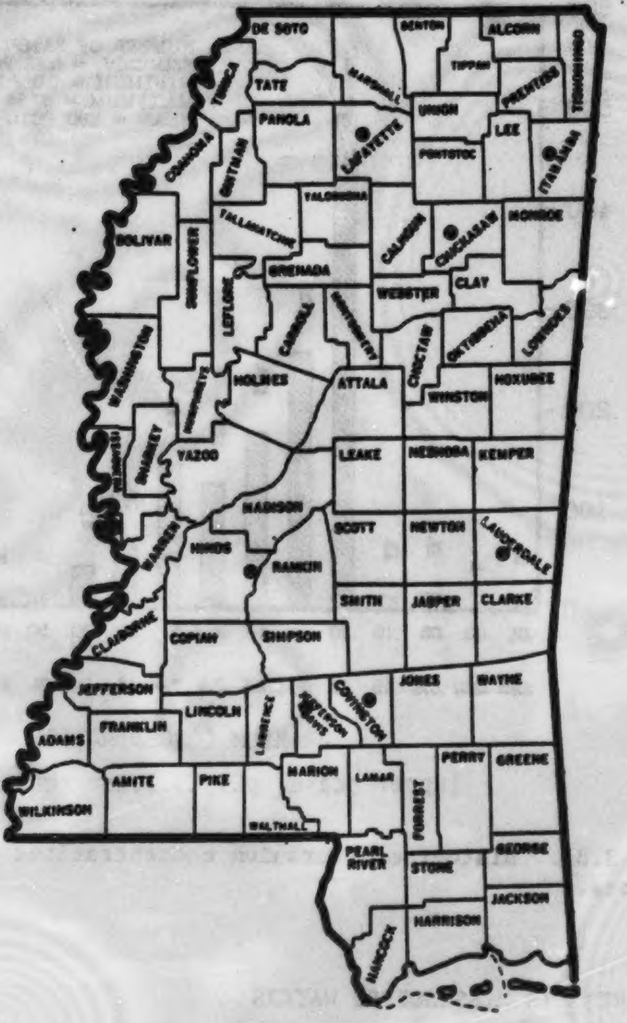

DE SOTO
BENTON
ALCORN
TUNICA
TATE
MARSHALL
TIPPAH
PRENTISS
TISHOMINGO
PANOLA
LAFAYETTE
UNION
LEE
ITAWAMBA
COAHOMA
QUITMAN
PONTOTOC
TALLAHATCHIE
YALOBUSHA
CALHOUN
CHICKASAW
MONROE
BOLIVAR
SUNFLOWER
GRENADA
WEBSTER
CLAY
LEFLORE
CARROLL
MONTGOMERY
CHOCTAW
OKTIBBEHA
LOWNDES
WASHINGTON
HOLMES
ATTALA
WINSTON
NOXUBEE
HUMPHREYS
SHARKEY
ISSAQUENA
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
SCOTT
NEWTON
LAUDERDALE
WARREN
HINDS
RANKIN
SMITH
JASPER
CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
JONES
WAYNE
LINCOLN
LAWRENCE
JEFFERSON DAVIS
COVINGTON
FRANKLIN
ADAMS
MARION
LAMAR
PERRY
GREENE
AMITE
PIKE
WILKINSON
WALTHALL
FORREST
PEARL RIVER
STONE
GEORGE
JACKSON
HARRISON
HANCOCK

Fig. 3.88. Locations of sample sites in Mississippi.

### 3.25.2 Concentrations of Uranium in Samples

3.25.2.1 Surface Waters — The concentration of uranium in the single recorded Mississippi surface water sample was 0.07 pCi/L (Fig. 3.89).

3.25.2.2 Ground Waters — Six Mississippi ground water analyses were recorded; all indicated 0.07 pCi/L uranium (Fig. 3.90).

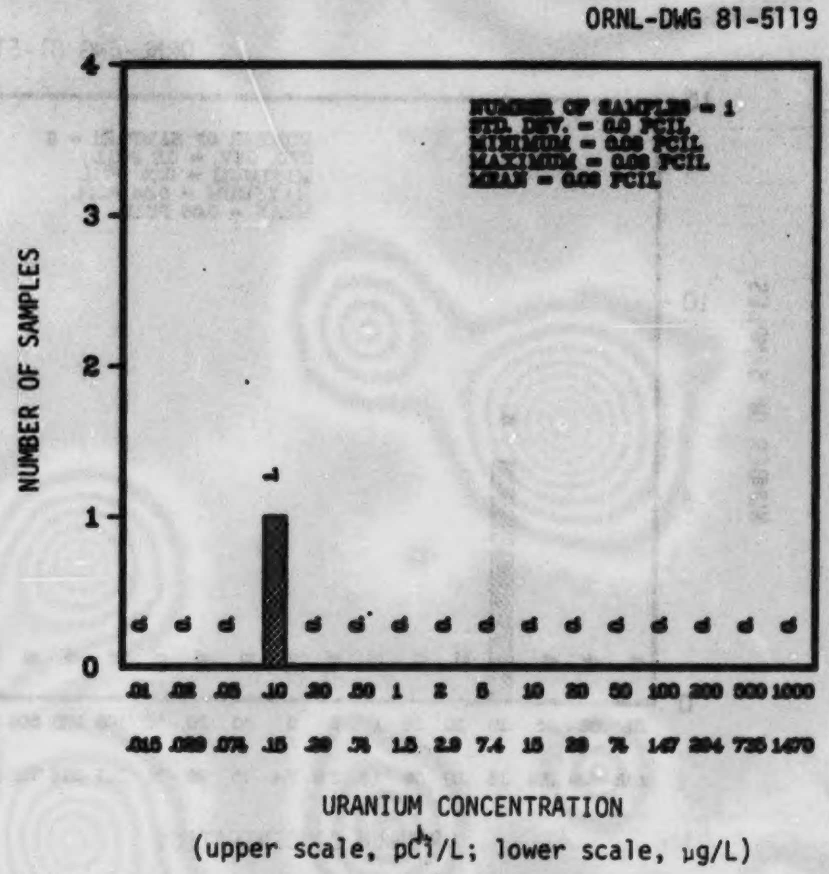


Fig. 3.89. Histogram of uranium concentrations in surface waters of Mississippi.

3.25.2.3 Established Domestic and Municipal Waters — All of the listed Mississippi sample sites were identified as sources of domestic water. All contained 0.07 pCi/L uranium or less (Fig. 3.91).

3.25.2.4 Treated Waters from Municipal Water Purification Plants — Processed water taken in 1962 from the municipal water purification plant in Jackson contained only 0.07 pCi/L uranium.

### 3.25.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Mississippi domestic water was estimated as <0.1 pCi/L, 17th highest

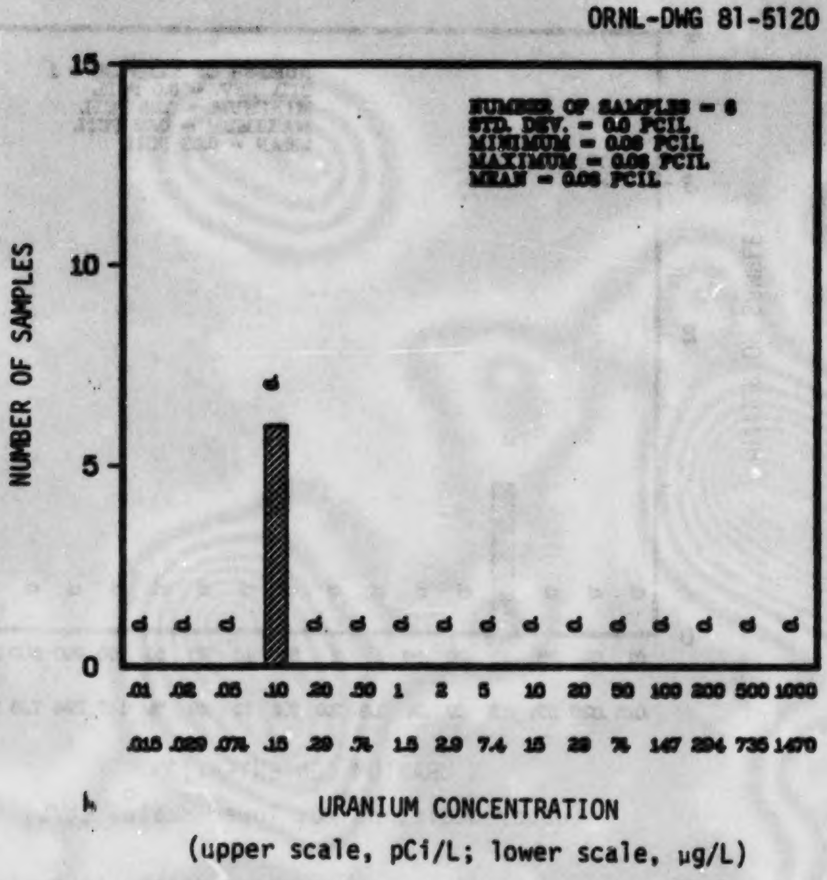


Fig. 3.90. Histogram of uranium concentrations in ground waters of Mississippi.

among all states (Appendix 2). The alpha radiation bone doses resulting from this average concentration were 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.25.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% of Mississippi water supplies contain uranium in excess of 1 pCi/L.

ORNL-DWG 81-5121

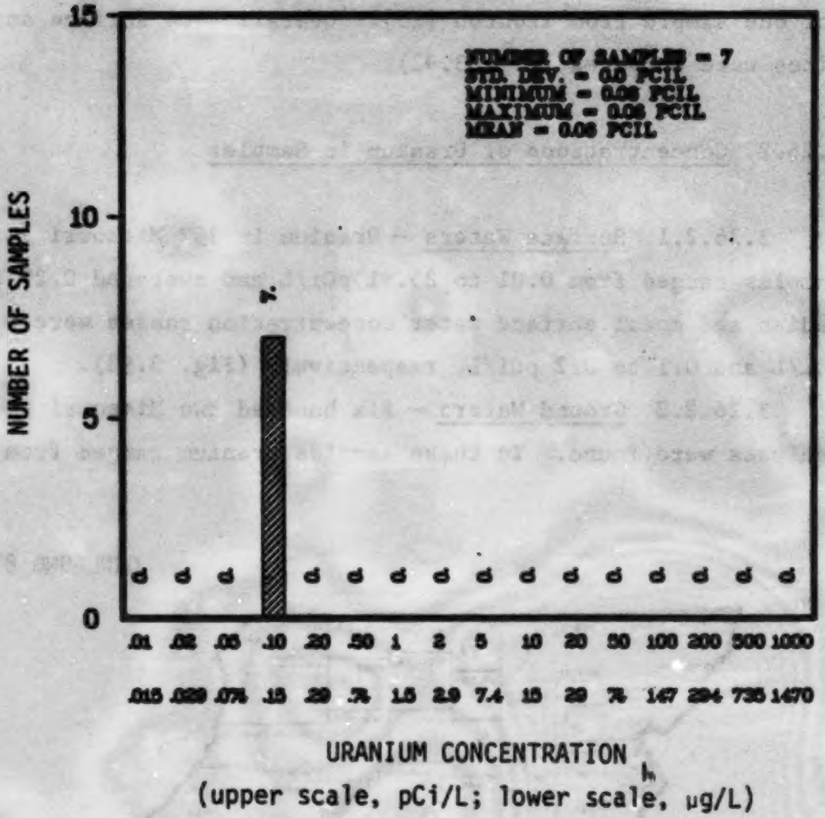


Fig. 3.91. Histogram of uranium concentrations in domestic waters of Mississippi.

## 3.26 URANIUM IN MISSOURI WATERS

### 3.26.1 Extent of Coverage

NURE analyses were reported only for those parts of Missouri contained within the Joplin, Poplar Bluff, and Dyersburg NTMS quadrangles [80,83,116]. These areas represent about 10% of the state's surface and mainly comprise the following southeastern and southwestern counties: Vernon, Barton, Jasper, Howell, Oregon, Ripley, Bulter, Stoddard, Mississippi, New Madrid, Pemiscot, and Dunklin. No data were available for sites outside the areas described above, except for treated water from the state's two largest cities, Kansas City and St. Louis [26], and for one sample from Ironton [15]. Overall, 964 surface and ground water sites were surveyed (Fig. 3.92).

### 3.26.2 Concentrations of Uranium in Samples

3.26.2.1 Surface Waters — Uranium in 362 Missouri surface water samples ranged from 0.01 to 25.91 pCi/L and averaged 0.29 pCi/L. The median and modal surface water concentration ranges were 0.05 to 0.1 pCi/L and 0.1 to 0.2 pCi/L, respectively (Fig. 3.93).

3.26.2.2 Ground Waters — Six hundred two Missouri ground water analyses were found. In these samples uranium ranged from 0.01 to 44.88

ORNL-DWG 81-5225

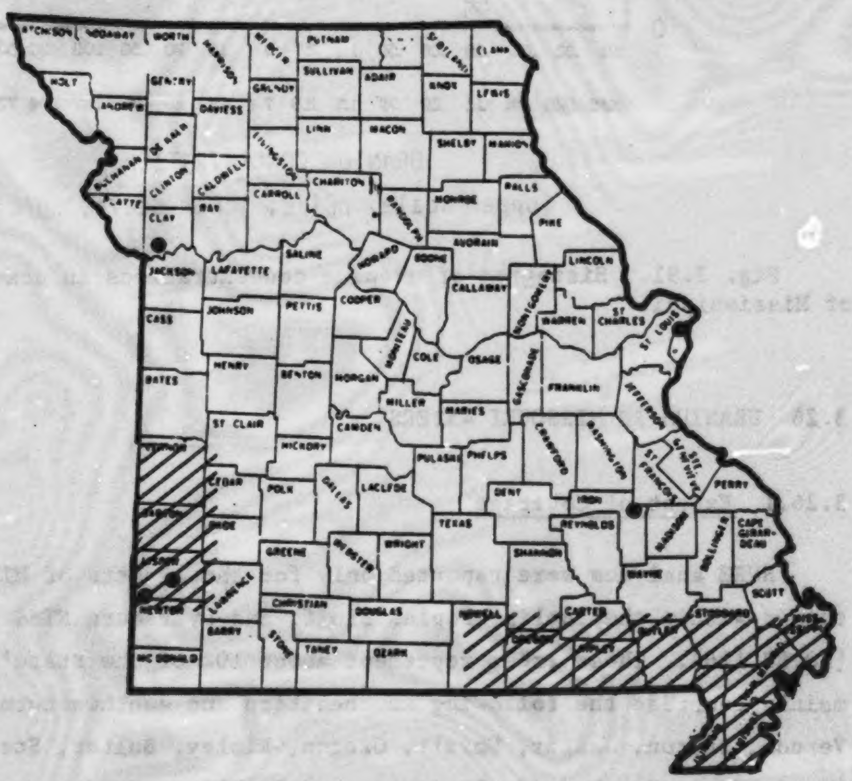

ATCHISON
NODAWAY
WORTH
HARRISON
MERCER
PUTNAM
SCHUYLER
CLARK
HOLT
GENTRY
GRUNDY
SULLIVAN
ADAIR
KNOX
LEWIS
ANDREW
DAVIESS
LINN
MACON
SHELBY
MARION
DE KALB
LIVINGSTON
BUCHANAN
CLINTON
CALDWELL
CARROLL
CHARITON
RANDOLPH
MONROE
RALLS
PLATTE
CLAY
RAY
PIKE
AUDRAIN
SALINE
HOWARD
BOONE
LINCOLN
JACKSON
LAFAYETTE
CALLAWAY
MONTGOMERY
COOPER
JOHNSON
PETTIS
WARREN
ST CHARLES
ST LOUIS
CASS
MONITEAU
COLE
OSAGE
GASCONADE
FRANKLIN
BATES
HENRY
BENTON
MORGAN
MILLER
MARIES
JEFFERSON
ST CLAIR
CAMDEN
CRAWFORD
WASHINGTON
STE GENEVIEVE
VERNON
HICKORY
PULASKI
PHELPS
ST FRANCOIS
PERRY
CEDAR
POLK
DALLAS
LACLEDE
DENT
IRON
BARTON
DADE
TEXAS
REYNOLDS
MADISON
BOLLINGER
CAPE GIRARDEAU
GREENE
WEBSTER
WRIGHT
SHANNON
WAYNE
JASPER
LAWRENCE
SCOTT
NEWTON
CHRISTIAN
DOUGLAS
HOWELL
CARTER
STODDARD
BARRY
STONE
TANEY
OZARK
OREGON
RIPLEY
BUTLER
MC DONALD

Fig. 3.92. Locations of sample sites in Missouri.

ORNL-DWG 81-5122

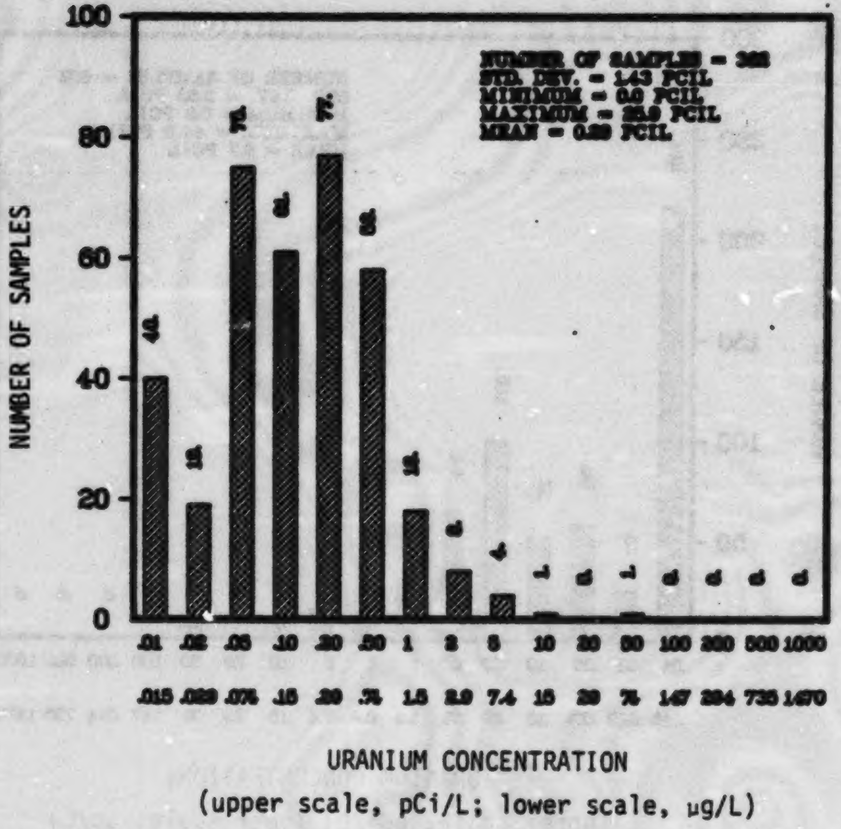


Fig. 3.93. Histogram of uranium concentrations in surface waters of Missouri.

pCi/L and averaged 0.71 pCi/L. The median concentration range was 0.05 to 0.1, but the mode was considerably lower, 0.01 pCi/L (Fig. 3.94).

3.26.2.3 Established Domestic and Municipal Waters — Sixty-five Missouri sites were identified as domestic water sources. Uranium in these samples varied from 0.11 to 3.30 pCi/L and averaged 0.34 pCi/L. The median and modal concentration ranges were identical, 0.1 to 0.2 pCi/L (Fig. 3.95).

3.26.2.4 Treated Waters from Municipal Water Purification Plants — The concentrations of uranium in processed waters from listed Missouri water treatment plants were low in 1961. Finished water from the Kansas

ORNL-DWG 81-5123

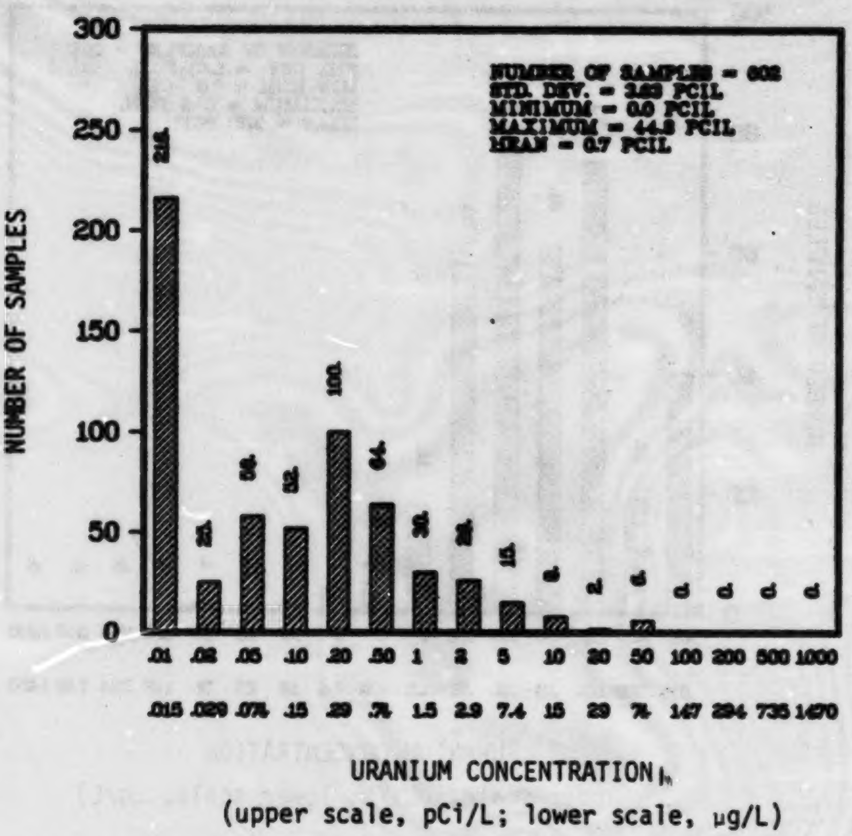


Fig. 3.94. Histogram of uranium concentrations in ground waters of Missouri.

City plant contained 0.14 pCi/L uranium, and waters from the Howard Bend and Chain of Rocks purification plants in St. Louis contained 0.34 and 0.68 pCi/L, respectively.

### 3.26.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Missouri domestic water was estimated as 0.3 pCi/L, 14th highest among all states (Appendix 2). Using this average concentration, the lifetime alpha radiation bone dose attributable to Missouri drinking water was estimated as 4 mrem/year for Model I and <1 mrem/year for Model II.

ORNL-DWG 81-5124

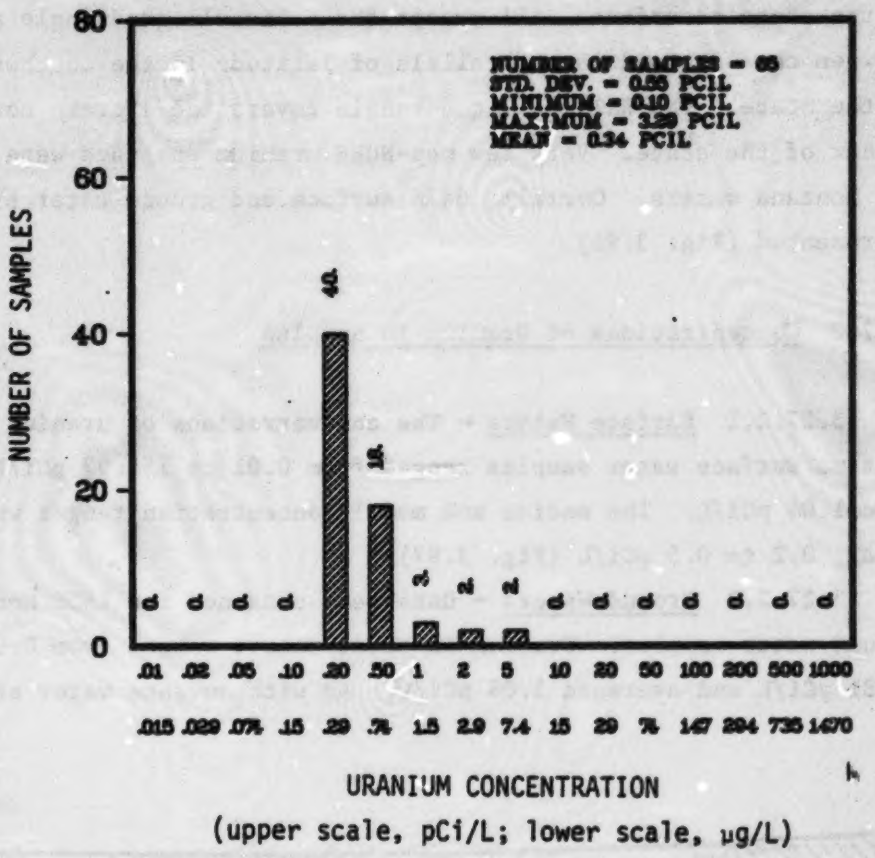


Fig. 3.95. Histogram of uranium concentrations in domestic waters of Missouri.

### 3.26.4 Water Supplies Exceeding Given Concentrations

We estimate that 0% to 6% of Missouri water supplies contain uranium in excess of 1 pCi/L, but that 0% exceed 5 pCi/L.

## 3.27 URANIUM IN MONTANA WATERS

### 3.27.1 Extent of Coverage

NURE data were available for the Billings, Bozeman, Dillion, Ekalaka, Elk City, Hamilton, and most of the Kalispell NTMS quadrangles in Montana [29,33,36,45-47,60]. These quadrangles encompass about 18% of the state's surface. All except the Kalispell quadrangle are located between the 45th and 46th parallels of latitude in the southwest corner of the state. The Kalispell quadrangle covers the extreme northwest corner of the state. Very few non-NURE uranium analyses were available for Montana waters. Overall, 6476 surface and ground water sites were represented (Fig. 3.96).

### 3.27.2 Concentrations of Uranium in Samples

3.27.2.1 Surface Waters — The concentrations of uranium in 4818 Montana surface water samples ranged from 0.01 to 154.97 pCi/L and averaged 1.04 pCi/L. The median and modal concentration ranges were identical, 0.2 to 0.5 pCi/L (Fig. 3.97).

3.27.2.2 Ground Waters — Data were obtained for 1658 Montana ground water samples. Uranium in these waters ranged from 0.01 to 84.81 pCi/L and averaged 3.08 pCi/L. As with surface water samples,

ORNL-DWG 81-5226

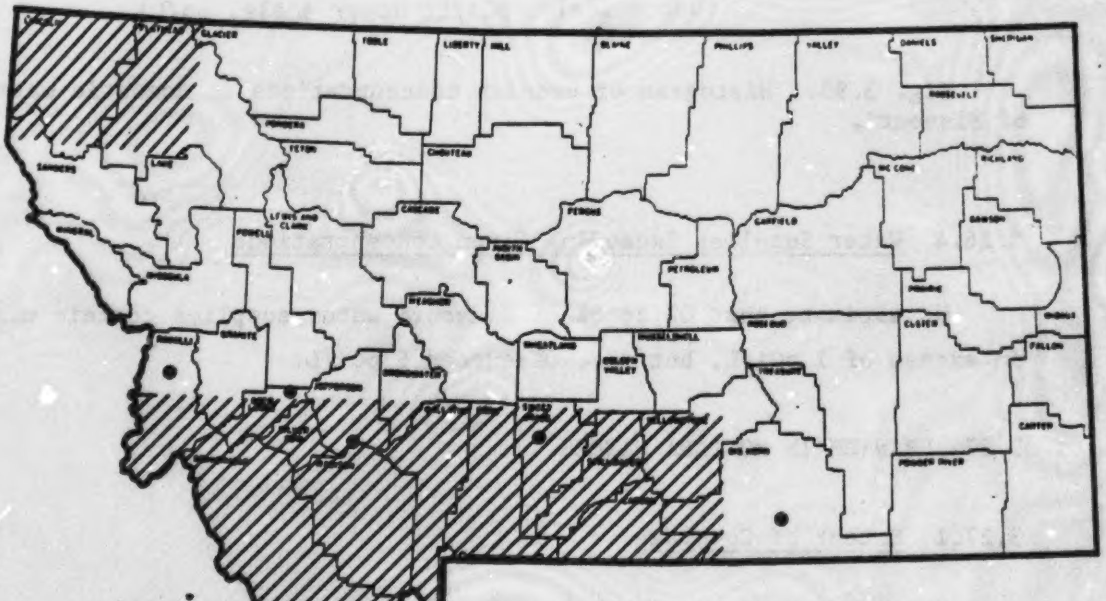

GLACIER
TOOLE
LIBERTY
HILL
BLAINE
PHILLIPS
VALLEY
DANIELS
SHERIDAN
ROOSEVELT
PONDERA
TETON
CHOUTEAU
SANDERS
LAKE
MINERAL
MISSOULA
LEWIS AND CLARK
POWELL
CASCADE
FERGUS
JUDITH BASIN
MEAGHER
PETROLEUM
GARFIELD
MC CONE
RICHLAND
DAWSON
PRAIRIE
WIBAUX
ROSEBUD
CUSTER
FALLON
GRANITE
RAVALLI
JEFFERSON
BROADWATER
WHEATLAND
GOLDEN VALLEY
MUSSELSHELL
TREASURE
SWEET GRASS
YELLOWSTONE
BIG HORN
POWDER RIVER
CARTER

Fig. 3.96. Locations of sample sites in Montana.

ORNL-DWG 81-5125

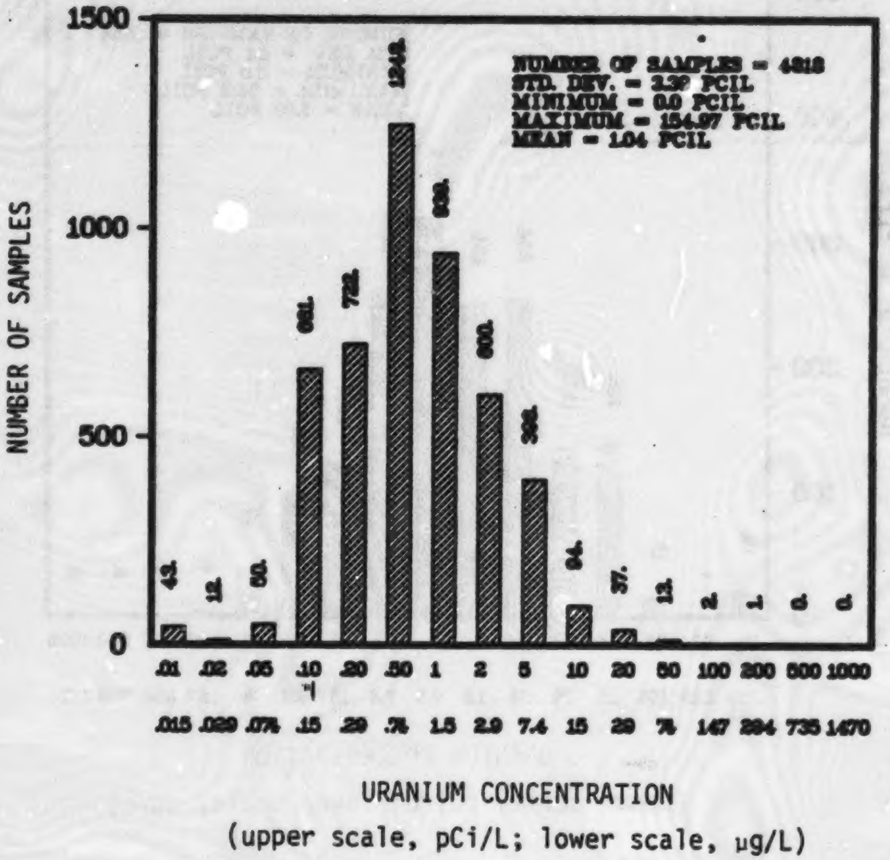


Fig. 3.97. Histogram of uranium concentrations in surface waters of Montana.

the median and modal ground water concentration ranges were identical, 1 to 2 pCi/L (Fig. 3.98).

3.27.2.3 Established Domestic and Municipal Waters — Sixty-two of the 6476 Montana sample sites were identified as domestic water sources. Uranium concentrations in these samples ranged from 0.07 to 31 pCi/L and averaged 3.29 pCi/L. The median and modal concentration ranges were identical, 1 to 2 pCi/L (Fig. 3.99).

3.27.2.4 Treated Waters from Municipal Water Purification Plants — No Montana samples were identified as treated waters from municipal water purification plants.

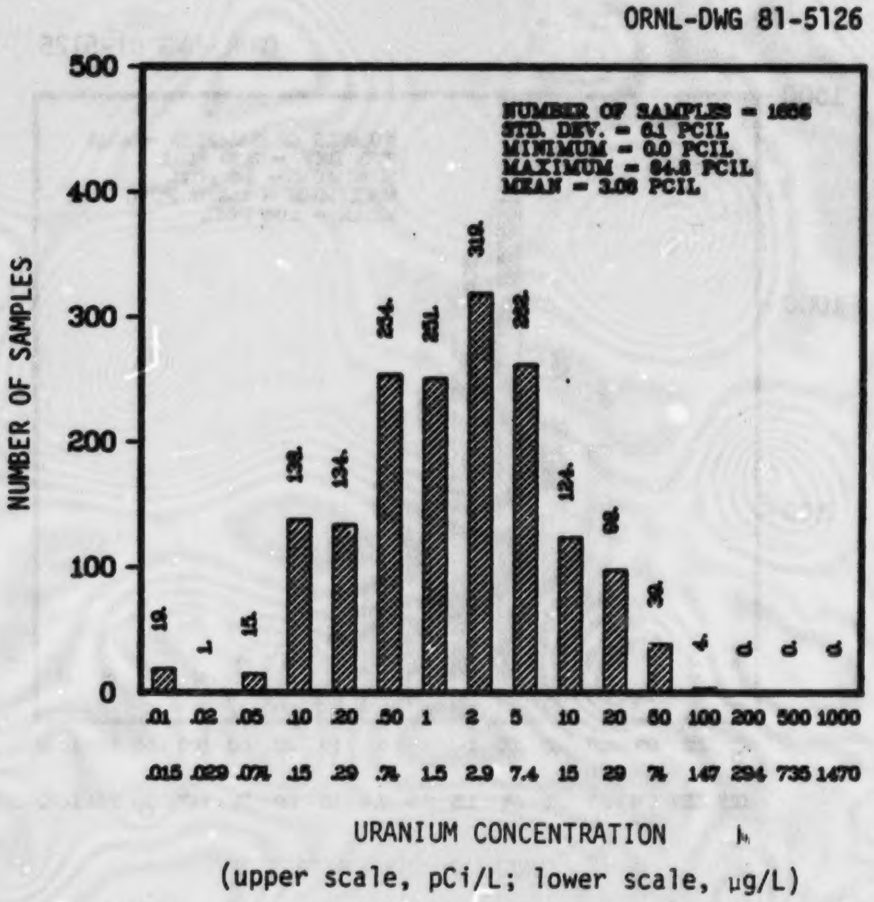


Fig. 3.98. Histogram of uranium concentrations in ground waters of Montana.

### 3.27.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Montana domestic water was estimated as 1.4 pCi/L, 8th highest among all states (Appendix 2). The corresponding lifetime alpha radiation bone dose attributable to Montana drinking water was 20 mrem/year for Model I and <1 mrem/year for Model II.

### 3.27.4 Water Supplies Exceeding Given Concentrations

We estimated that 53% to 80% of Montana water supplies contain uranium in excess of 1 pCi/L; 0% to 18%, in excess of 5 pCi/L; 0% to 10%, in excess of 10 pCi/L; and 0% to 3% in excess of 20 pCi/L.

ORNL-DWG 81-5127

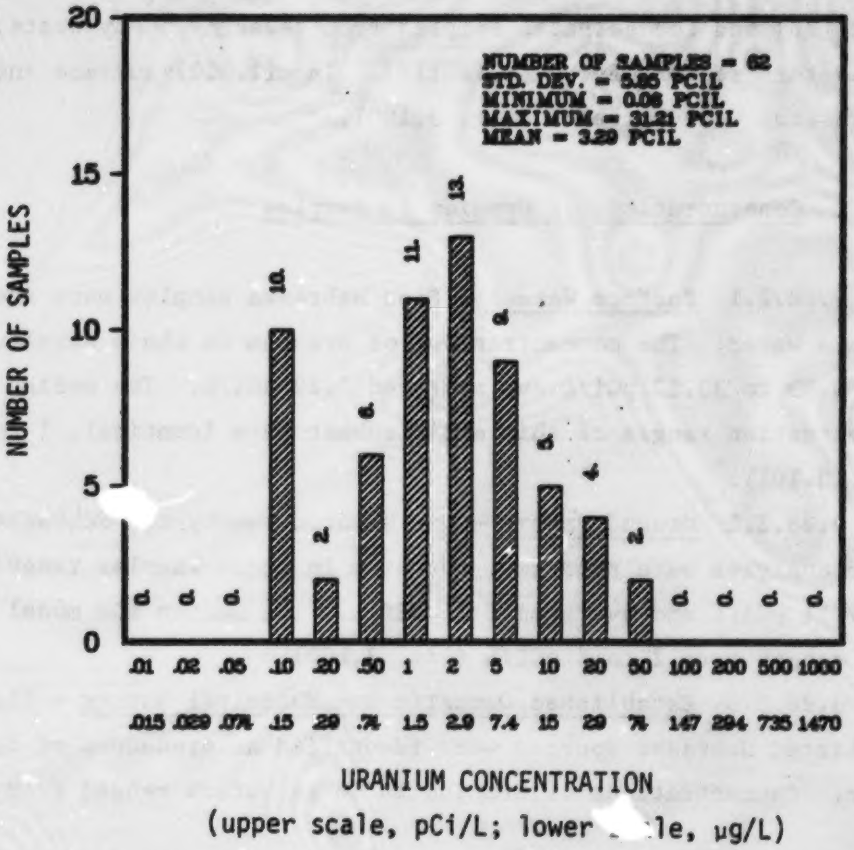


Fig. 3.99. Histogram of uranium concentrations in domestic waters of Montana.

## 3.28 URANIUM IN NEBRASKA WATERS

### 3.28.1 Extent of Coverage

NURE personnel have systematically sampled almost all of the waters of Nebraska for uranium, but most of these analyses were not available at the time this report was written. A few Nebraska sources were sampled during the Cheyenne (Wyoming) quadrangle survey [58]; these are included in the following summary but are not shown on Fig. 3.99. All of these sample sites lie near the Wyoming border in Scotts Bluff, Banner, and Kimball counties. Non-NURE data were available for processed waters from water purification facilities in the two largest cities of the state [26] and for selected samples from several county seats, mostly in the eastern sector of the state [15]. In all, 127 surface and ground water sites were surveyed (Fig. 3.100).

## 3.28.2 Concentrations of Uranium in Samples

3.28.2.1 Surface Waters — Five Nebraska samples were identified as surface water. The concentrations of uranium in these samples varied from 0.03 to 33.12 pCi/L and averaged 7.29 pCi/L. The median and modal concentration ranges of this small subset were identical, 1 to 2 pCi/L (Fig. 3.101).

3.28.2.2 Ground Waters — One hundred twenty-two Nebraska ground water analyses were recorded. Uranium in these samples ranged from 0.01 to 67.11 pCi/L and averaged 5.31 pCi/L. The median and modal concentration ranges were 2 to 5 pCi/L (Fig. 3.102).

3.28.2.3 Established Domestic and Municipal Waters — Eighteen of the listed Nebraska sources were identified as producers of domestic water. Concentrations of uranium in these waters ranged from 0.14 to

ORNL-DWG 81-5227

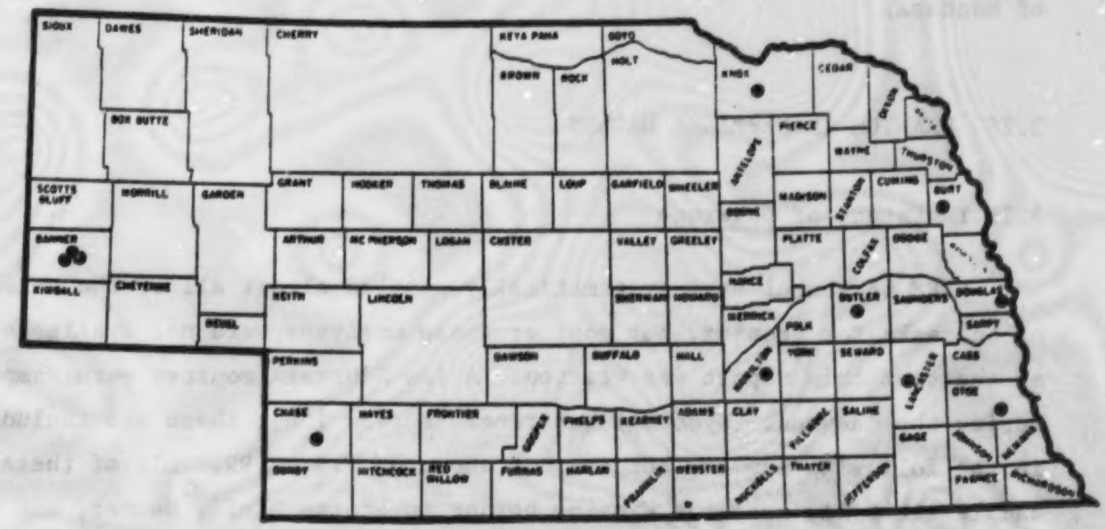

SIOUX
DAWES
SHERIDAN
CHERRY
KEYA PAHA
BOYD
BROWN
ROCK
HOLT
KNOX
CEDAR
DIXON
DAKOTA
BOX BUTTE
ANTELOPE
PIERCE
WAYNE
THURSTON
SCOTTS BLUFF
MORRILL
GARDEN
GRANT
HOOKER
THOMAS
BLAINE
LOUP
GARFIELD
WHEELER
MADISON
STANTON
CUMING
BURT
BOONE
BANNER
ARTHUR
MC PHERSON
LOGAN
CUSTER
VALLEY
GREELEY
PLATTE
COLFAX
DODGE
WASHINGTON
NANCE
KIMBALL
CHEYENNE
KEITH
LINCOLN
SHERMAN
HOWARD
MERRICK
BUTLER
SAUNDERS
DOUGLAS
DEUEL
POLK
SARPY
PERKINS
DAWSON
BUFFALO
HALL
HAMILTON
YORK
SEWARD
LANCASTER
CASS
OTOE
CHASE
HAYES
FRONTIER
GOSPER
PHELPS
KEARNEY
ADAMS
CLAY
FILLMORE
SALINE
GAGE
JOHNSON
NEMAHA
DUNDY
HITCHCOCK
RED WILLOW
FURNAS
HARLAN
FRANKLIN
WEBSTER
NUCKOLLS
THAYER
JEFFERSON
PAWNEE
RICHARDSON

Fig. 3.100. Locations of sample sites in Nebraska.

ORNL-DWG 81-5128

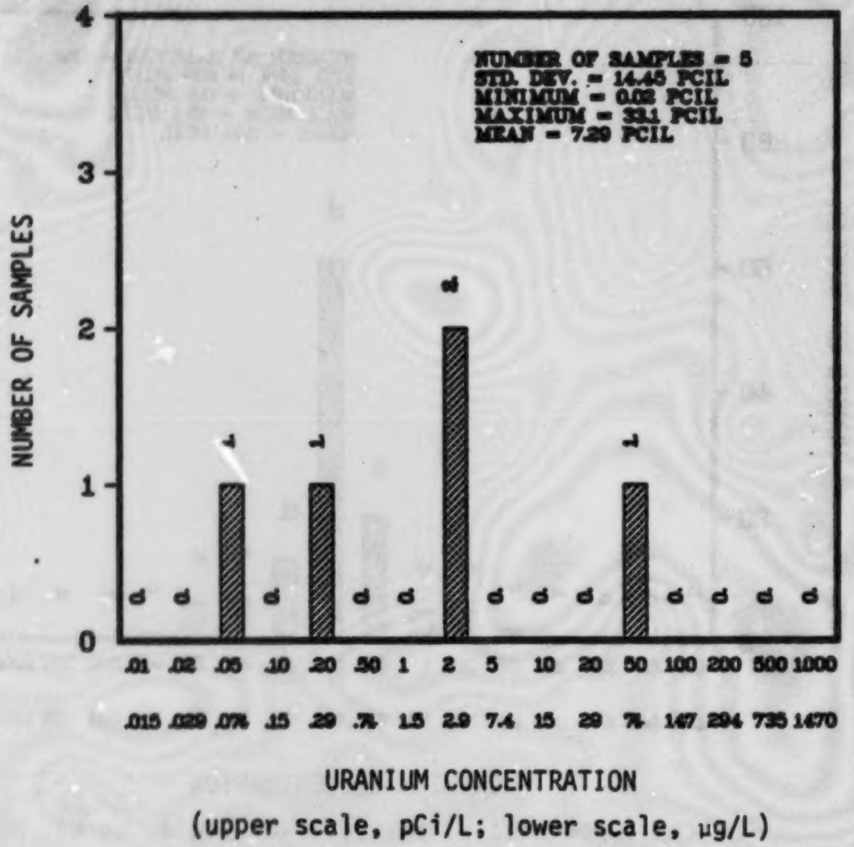


Fig. 3.101. Histogram of uranium concentrations in surface waters of Nebraska.

15 pCi/L and averaged 3.91 pCi/L. The median and modal concentration ranges were identical, 1 to 2 pCi/L (Fig. 3.103).

3.28.2.4 Treated Waters from Municipal Water Purification Plants — In 1962, finished water from the Ashland purification plant in Lincoln contained 3.5 pCi/L uranium. A similar sample from the Minne Lusa treatment plant in Omaha contained 1.8 pCi/L.

### 3.28.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Nebraska domestic waters was estimated as 1.8 pCi/L, 7th highest among all states

ORNL-DWG 81-5129

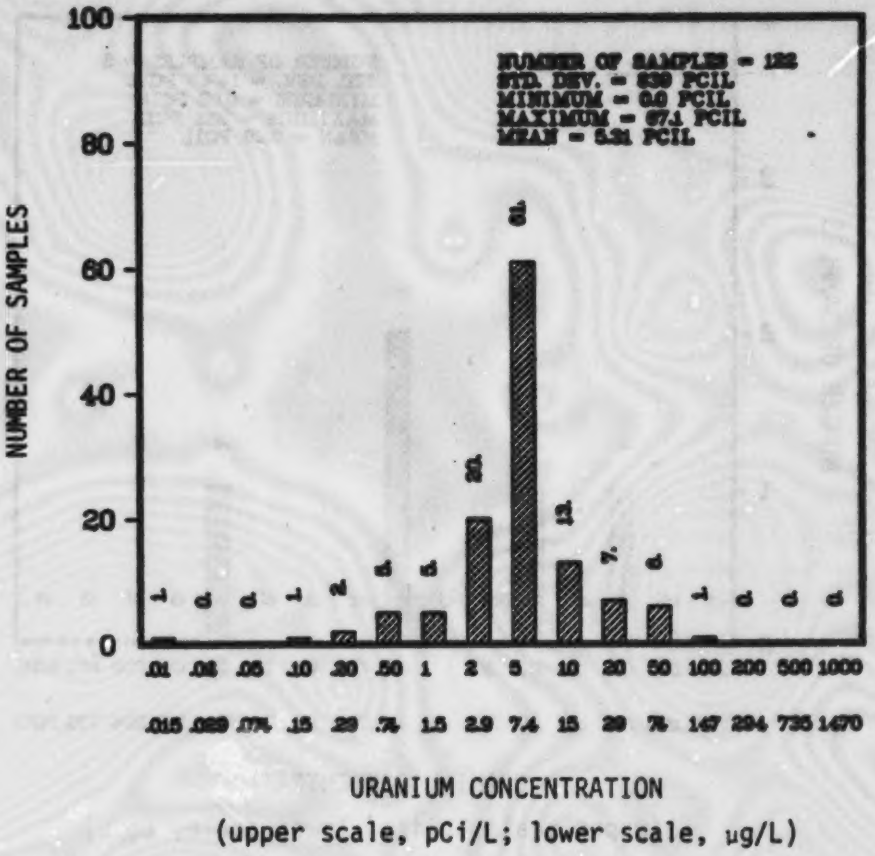


Fig. 3.102. Histogram of uranium concentrations in ground waters of Nebraska.

(Appendix 2). The estimated lifetime alpha radiation bone dose attributable to uranium in drinking water was 27 mrem/year for Model I and 1 mrem/year for Model II.

### 3.28.4 Water Supplies Exceeding Given Concentrations

We estimated that 78% to 88% of all Nebraska water supplies contain uranium in excess of 1 pCi/L; 0% to 28%, in excess of 5 pCi/L; 0% to 17%, in excess of 10 pCi/L; and 0%, in excess of 20 pCi/L.

ORNL-DWG 81-5130

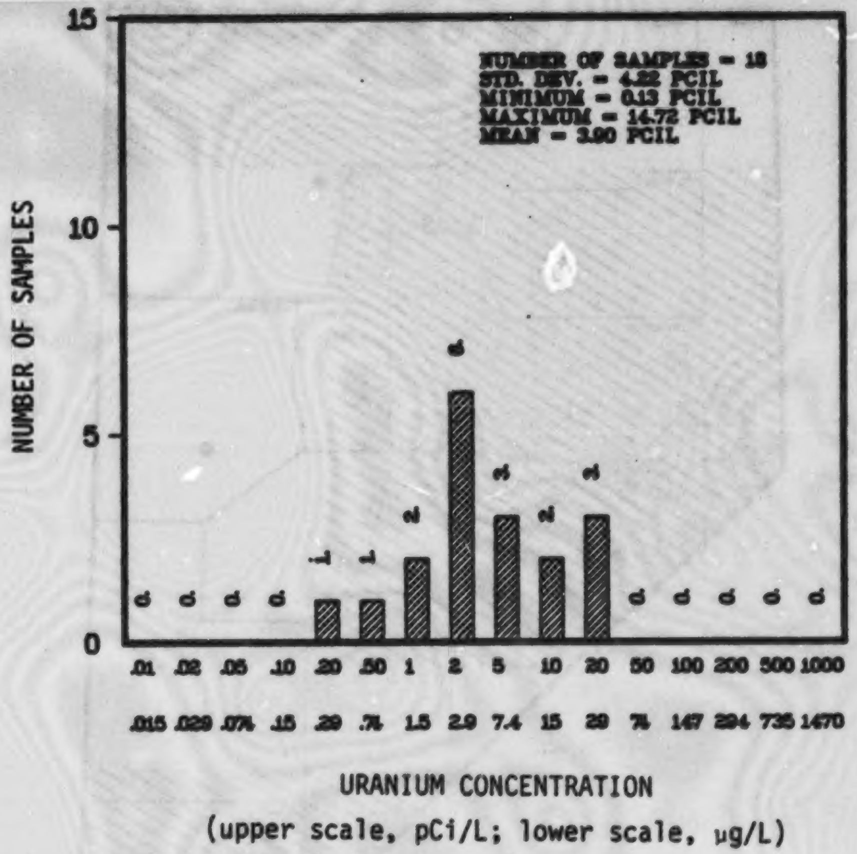


Fig. 3.103. Histogram of uranium concentrations in domestic waters of Nebraska.

## 3.29 URANIUM IN NEVADA WATERS

### 3.29.1 Extent of Coverage

NURE data were available for about 56% of the state's area [88–93, 131,132,135]. Only the east-central, extreme northwestern, and Goldfield sectors remain unreported. Non-NURE analyses for a few additional sites were also found, mostly within the area covered by the NURE surveys. Included were data for treated water from the municipal water treatment plant of the state's largest city, Las Vegas [1,26]. Overall, 1165 surface and ground water sites were represented (Fig. 3.104).

ORNL-DWG 81-5228

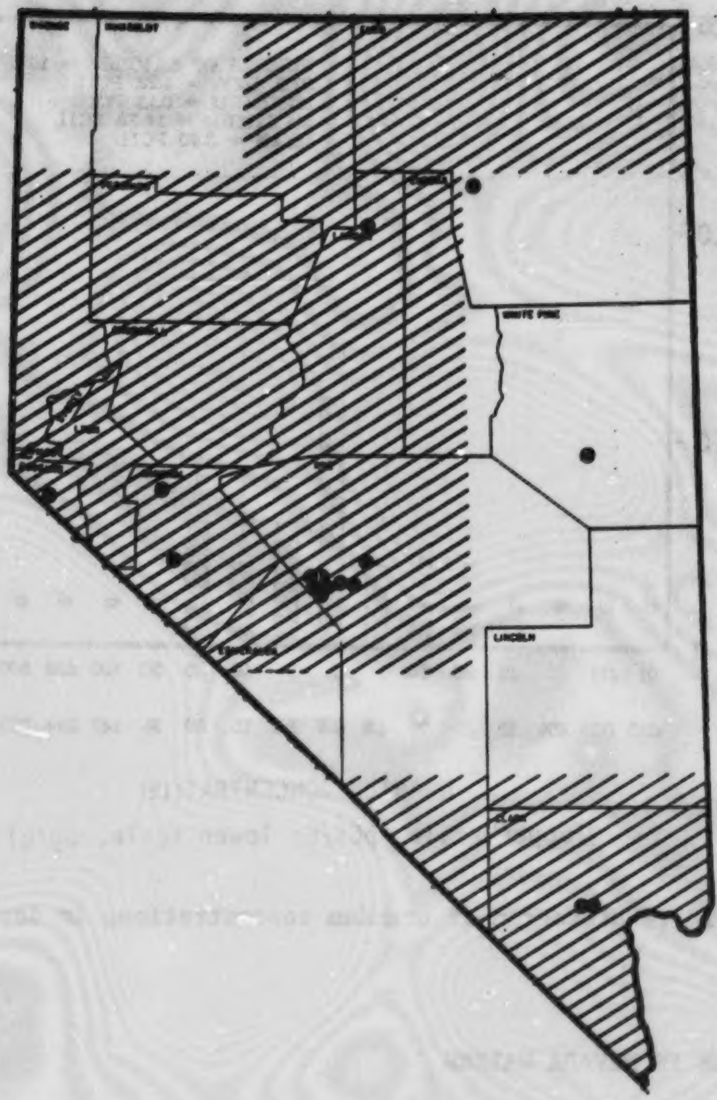

WASHOE
HUMBOLDT
ELKO
WHITE PINE
ESMERALDA
LINCOLN
CLARK

Fig. 3.104. Locations of sample sites in Nevada.

### 3.29.2 Concentrations of Uranium in Samples

3.29.2.1 Surface Waters — Uranium in 200 Nevada surface water samples ranged from 0.01 to 9.16 pCi/L and averaged 1.75 pCi/L. The most frequently occurring concentration range was 2 to 5 pCi/L, but the median range was somewhat lower, 1 to 2 pCi/L (Fig. 3.105).

ORNL-DWG 81-5131

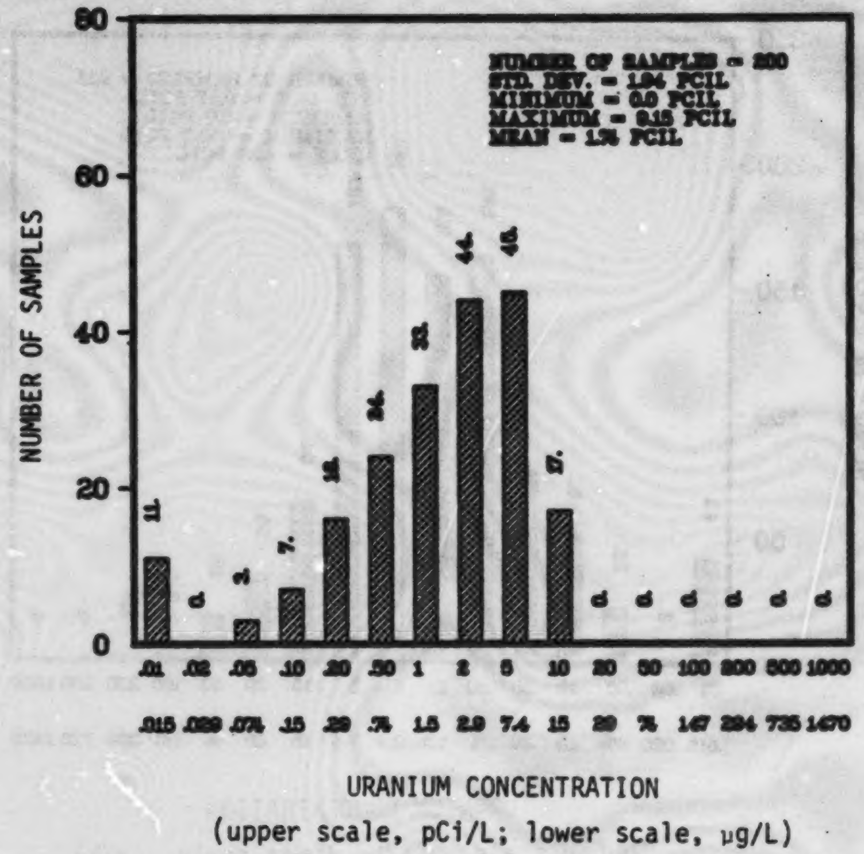


Fig. 3.105. Histogram of uranium concentrations in surface waters of Nevada.

3.29.2.2 Ground Waters — Nine hundred sixty-five Nevada ground water analyses were available. Uranium in these samples ranged from 0.01 to 121.79 pCi/L and averaged 3.30 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L and 1 to 2 pCi/L, respectively (Fig. 3.106).

3.29.2.3 Established Domestic and Municipal Waters — Ninety-nine Nevada sites were identified as domestic water sources. The concentrations of uranium in these samples ranged from 0.03 to 13.60 pCi/L and averaged 2.50 pCi/L. The median and modal concentration ranges for these samples were identical, 1 to 2 pCi/L (Fig. 3.107).

ORNL-DWG 81-5132

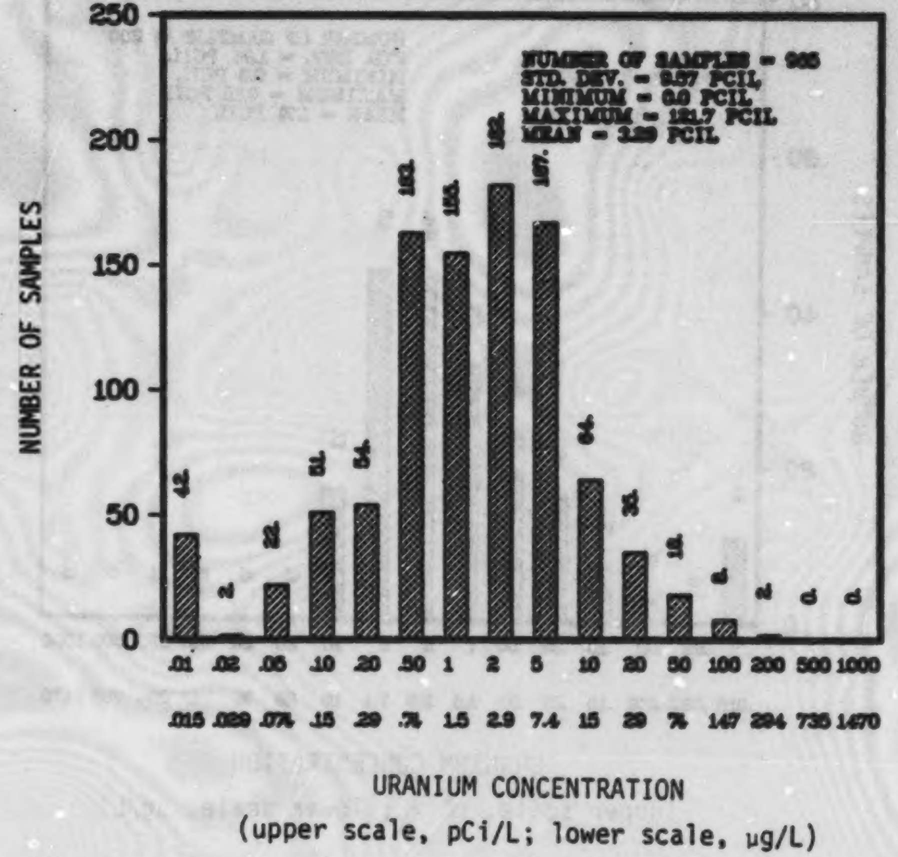


Fig. 3.106. Histogram of uranium concentrations in ground waters of Nevada.

3.29.2.4 Treated Waters from Municipal Water Purification Plants — Treated water from the Las Vegas municipal system, composited between July and December, 1977, contained 3.150, 0.111, and 2.080 pCi/L of $^{234}$U, $^{235}$U, and $^{238}$U, respectively. The total uranium activity of this sample was 5.341 pCi/L. The uranium content of this sample was greater than that in treated water from any of the other 21 U.S. cities regularly monitored by the EPA Office of Radiation Programs in 1977 [1].

### 3.29.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Nevada domestic waters was estimated as 4.3 pCi/L, 2d highest among all states

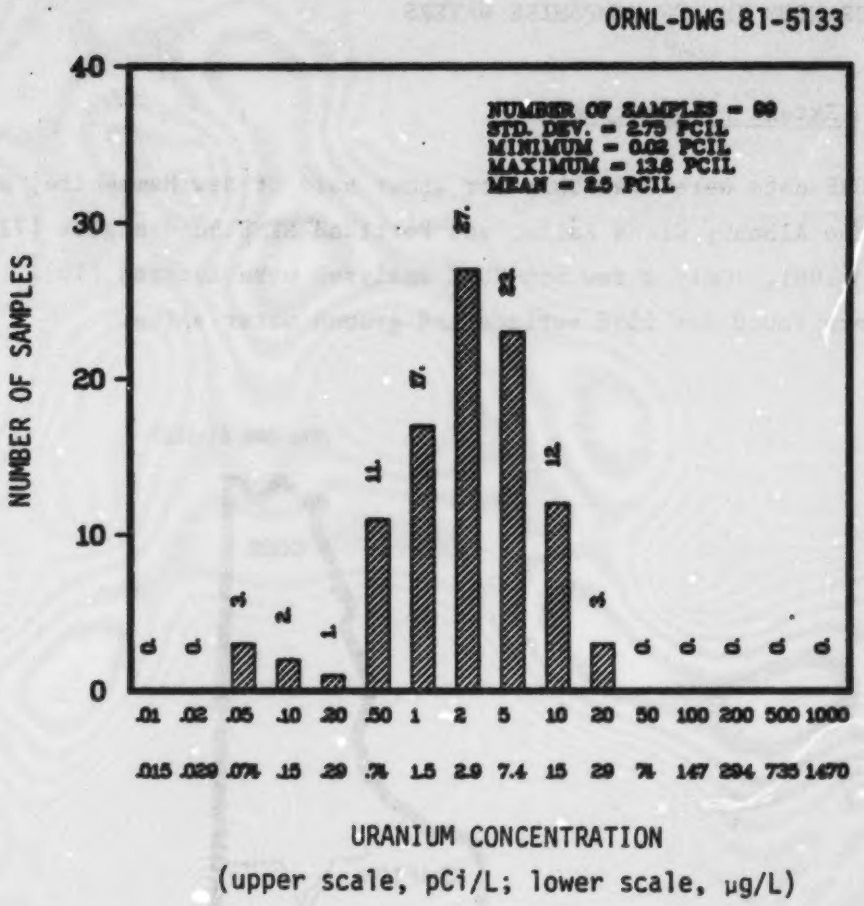


Fig. 3.107. Histogram of uranium concentrations in domestic waters of Nevada.

(Appendix 2). The corresponding alpha radiation bone doses were calculated to be 65 mrem/year for Model I and 2 mrem/year for Model II.

### 3.29.4 Water Supplies Exceeding Given Concentrations

We estimated that 66% to 100% of all Nevada water supplies contain uranium in excess of 1 pCi/L; 15% to 100%, in excess of 5 pCi/L; 0% to 3%, in excess of 10 pCi/L; and 0%, in excess of 10 pCi/L.

## 3.30 URANIUM IN NEW HAMPSHIRE WATERS

### 3.30.1 Extent of Coverage

NURE data were available for about half of New Hampshire, specifically the Albany, Glens Falls, and Portland NTMS quadrangles [72,79,82] (Fig. 3.108). Only a few non-NURE analyses were located [15]. Overall, data were found for 1556 surface and ground water sites.

ORNL-DWG 81-5229

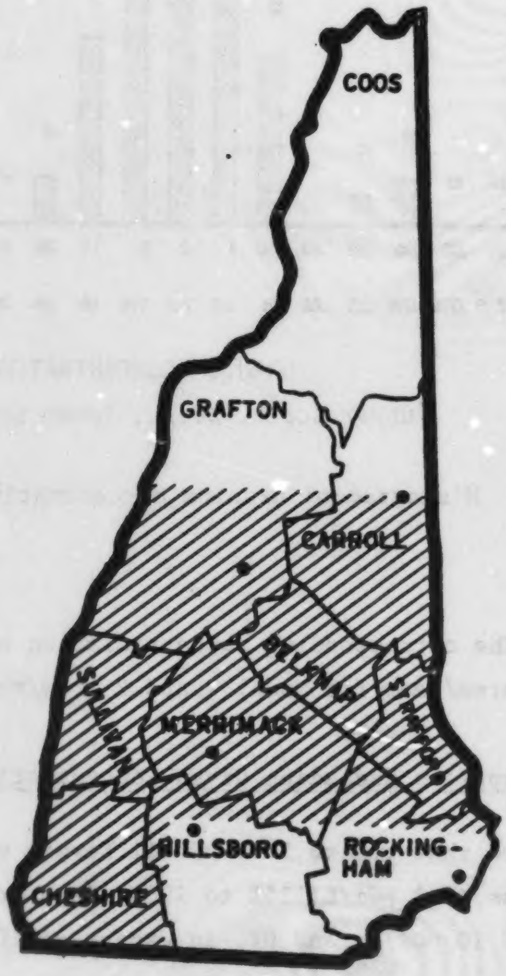

COOS
GRAFTON
CARROLL
BELKNAP
STRAFFORD
SULLIVAN
MERRIMACK
HILLSBORO
ROCKING-
HAM
CHESHIRE

Fig. 3.108. Locations of sample sites in New Hampshire.

### 3.30.2 Concentrations of Uranium in Samples

3.30.2.1 Surface Waters — Analyses were obtained for 1013 New Hampshire surface waters. The concentrations of uranium in these samples ranged from 0.01 to 7.77 pCi/L and averaged 0.04 pCi/L. The mode was 0.01 pCi/L, and the median concentration range was 0.01 to 0.02 pCi/L (Fig. 3.109).

3.30.2.2 Ground Waters — Data were obtained for 548 New Hampshire ground water samples. Uranium ranged from 0.01 to 65.41 pCi/L and averaged 0.65 pCi/L. The median and modal concentration ranges of these samples were identical, 0.02 to 0.05 pCi/L (Fig. 3.110).

3.30.2.3 Established Domestic and Municipal Waters — Four hundred ninety-one New Hampshire water sites were identified as domestic water

ORNL-DWG 81-5134

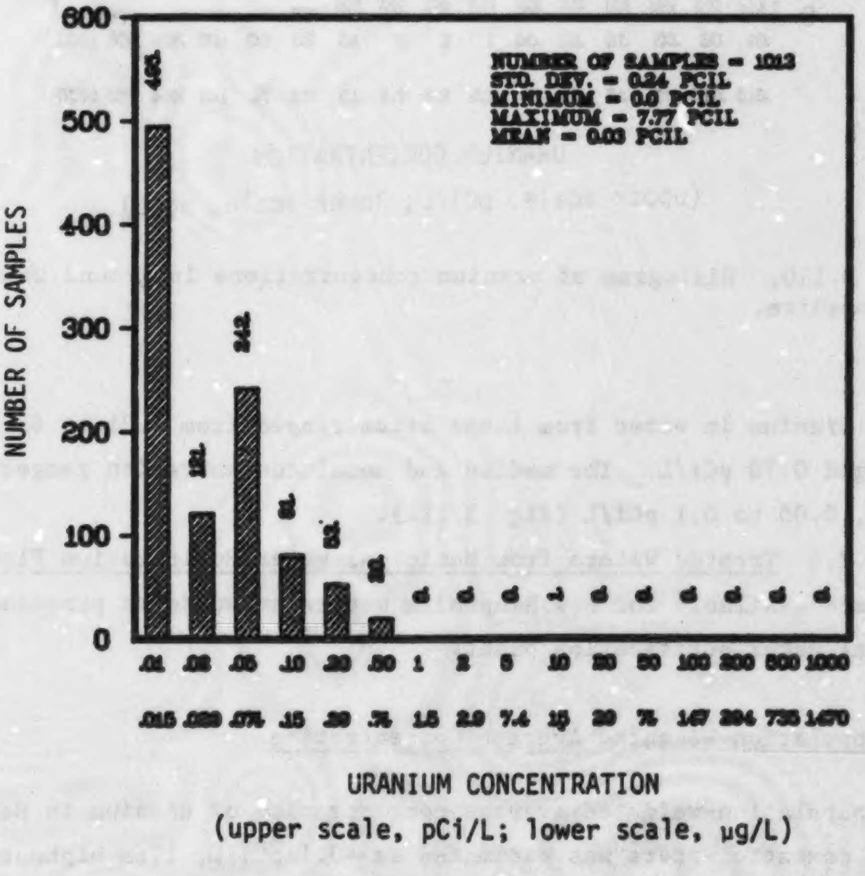


Fig. 3.109. Histogram of uranium concentrations in surface waters of New Hampshire.

ORNL-DWG 81-3135

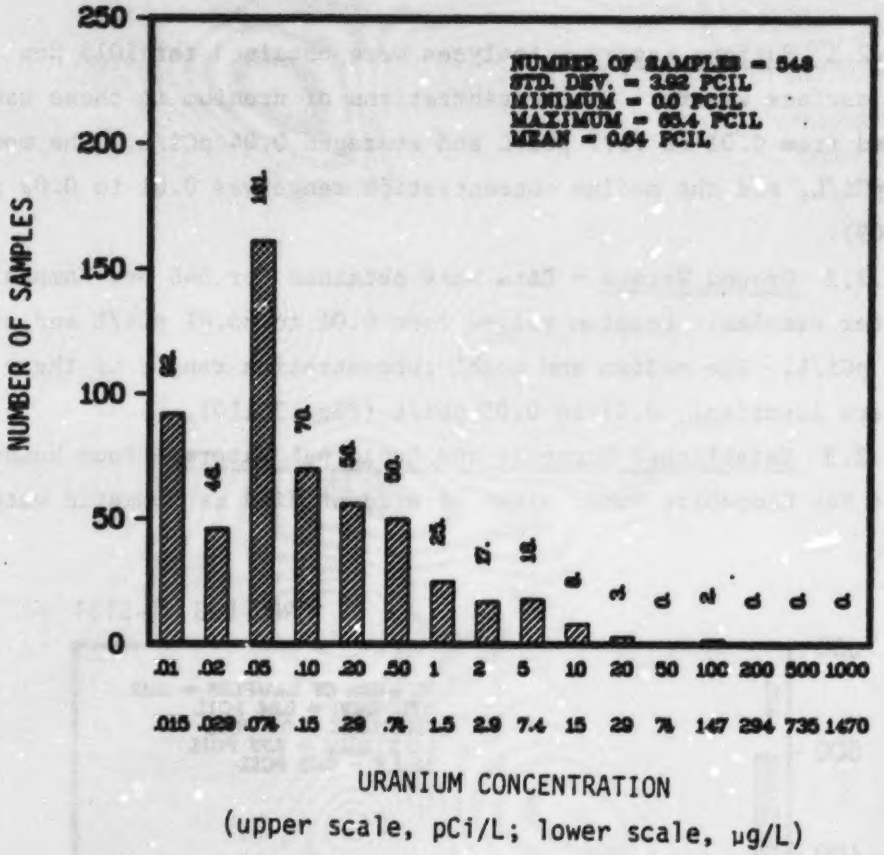


Fig. 3.110. Histogram of uranium concentrations in ground waters of New Hampshire.

sources. Uranium in water from these sites ranged from 0.01 to 65 pCi/L and averaged 0.70 pCi/L. The median and modal concentration ranges were identical, 0.05 to 0.1 pCi/L (Fig. 3.111).

3.30.2.4 Treated Waters from Municipal Water Purification Plants — No data were available for New Hampshire waters known to be processed in a municipal water purification plant.

### 3.30.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in New Hampshire domestic waters was estimated as <0.1 pCi/L, 17th highest

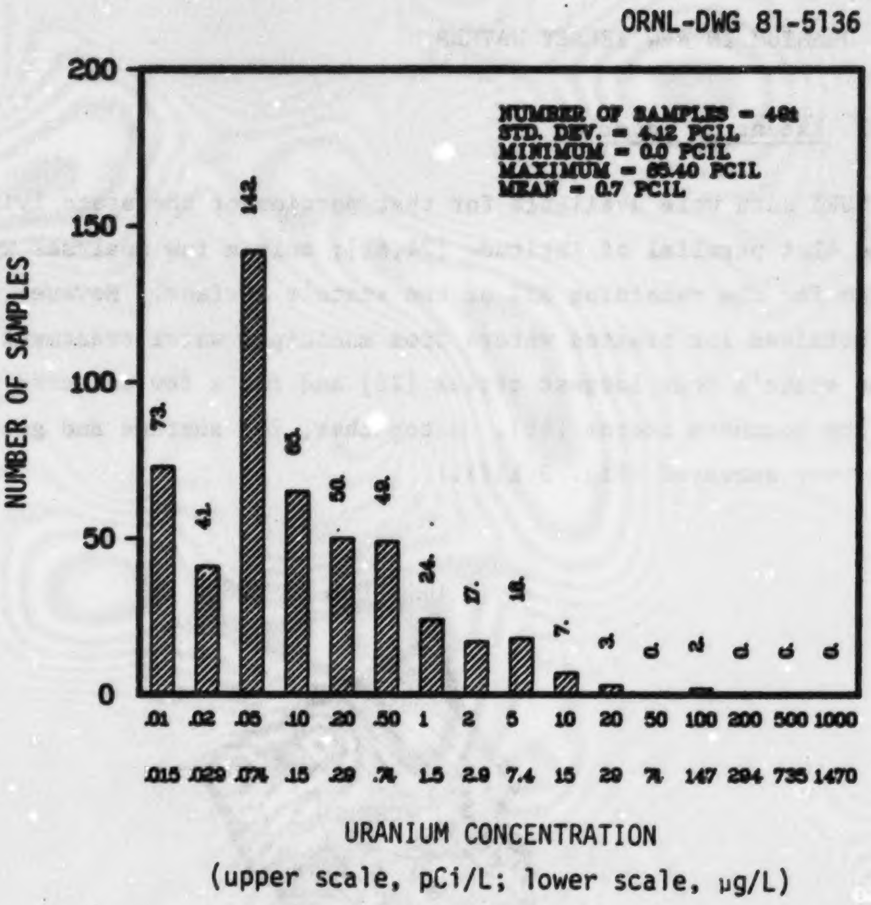


**Fig. 3.111. Histogram of uranium concentrations in domestic waters of New Hampshire.**

**among all states (Appendix 2). Based on this average, the alpha radiation bone dose was <1 mrem/year for both Model I and Model II.**

### 3.30.4 Water Supplies Exceeding Given Concentrations

**We estimated that 0% to 10% of New Hampshire water supplies have uranium concentrations exceeding 1 pCi/L; 0% to 2%, exceeding 5 pCi/L; 0% to 1%, exceeding 10 pCi/L; and 0% to 0.4%, exceeding 20 pCi/L.**

## 3.31 URANIUM IN NEW JERSEY WATERS

### 3.31.1 Extent of Coverage

NURE data were available for that portion of the state lying north of the 41st parallel of latitude [74,81]; only a few analyses were located for the remaining 85% of the state's surface. However, assays were obtained for treated waters from municipal water treatment plants in the state's four largest cities [26] and for a few selected samples from the southern sector [15]. Altogether, 243 surface and ground water sites were surveyed (Fig. 3.112).

ORNL-DWG 81-5230

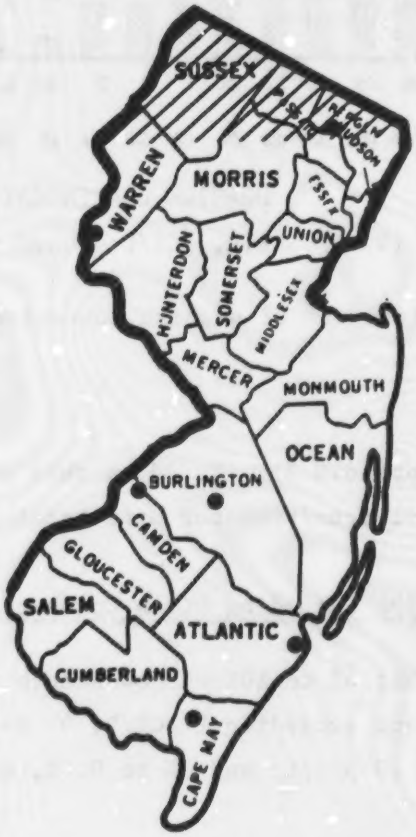

SUSSEX
HUDSON
WARREN
MORRIS
ESSEX
UNION
HUNTERDON
SOMERSET
MIDDLESEX
MERCER
MONMOUTH
OCEAN
BURLINGTON
CAMDEN
GLOUCESTER
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY

Fig. 3.112. Locations of sample sites in New Jersey.

### 3.31.2 Concentrations of Uranium in Samples

3.31.2.1 Surface Waters — The concentrations of uranium in all New Jersey waters were low. The concentrations in 99 surface waters ranged from 0.01 to 2.28 pCi/L and averaged 0.11 pCi/L. The mode was 0.01 pCi/L, and the median concentration range was 0.01 to 0.02 pCi/L (Fig. 3.113).

3.31.2.2 Ground Waters — In 144 New Jersey ground water samples, uranium varied from 0.01 to 4.88 pCi/L and averaged 0.28 pCi/L. The most frequently occurring uranium concentration was 0.01 pCi/L, but the median concentration range was somewhat higher, 0.05 to 0.1 pCi/L (Fig. 3.114).

ORNL-DWG 81-5137

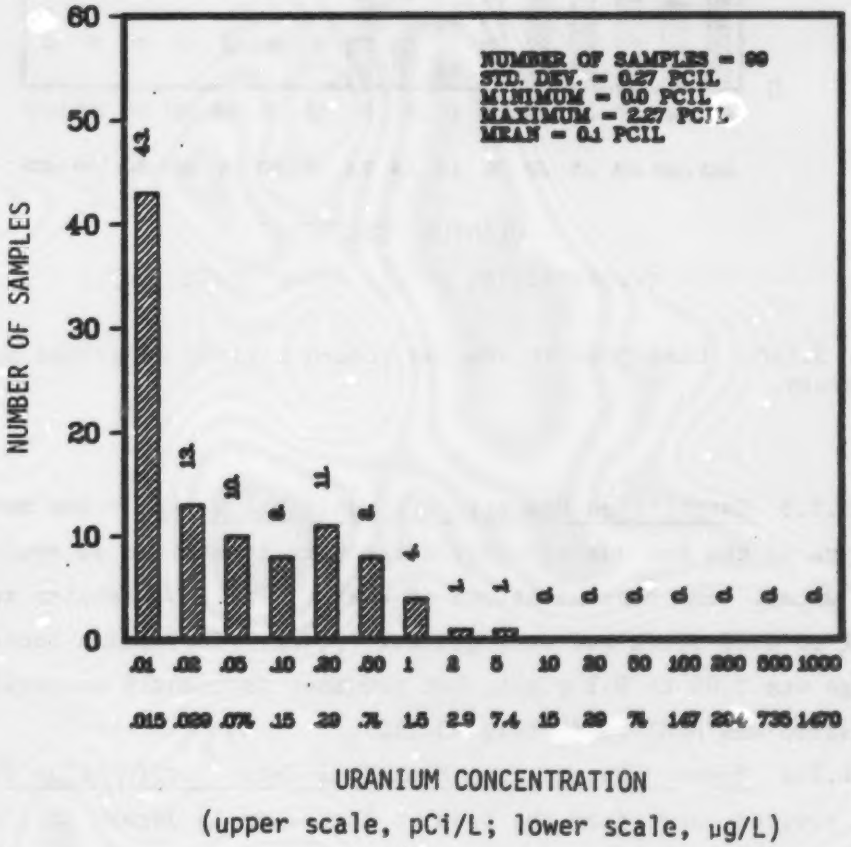


Fig. 3.113. Histogram of uranium concentrations in surface waters of New Jersey.

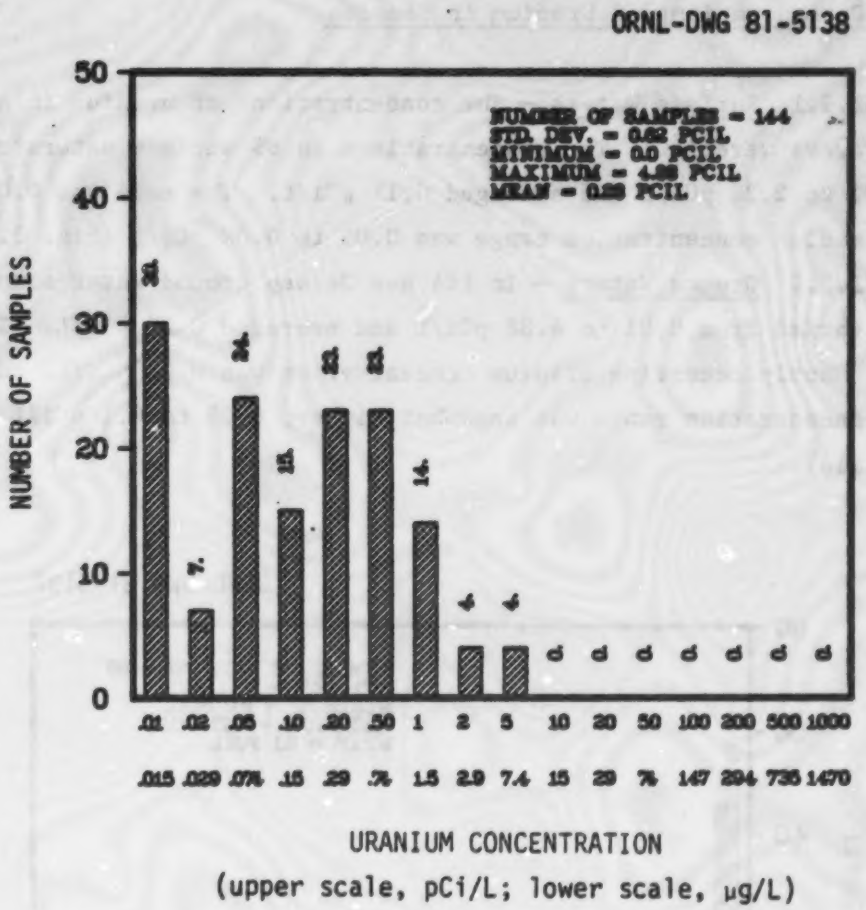


Fig. 3.114. Histogram of uranium concentrations in ground waters of New Jersey.

3.31.2.3 Established Domestic and Municipal Waters — One hundred thirty-five of the New Jersey water sites were identified as sources of domestic water. The concentrations of uranium in these samples ranged from 0.01 to 4.88 pCi/L and averaged 0.29 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L, but the most frequently occurring concentration was 0.01 pCi/L (Fig. 3.115).

3.31.2.4 Treated Waters from Municipal Water Purification Plants — In 1962, treated water from the Boonton Reservoir in Jersey City contained 0.07 pCi/L uranium. Similar samples from the Wanaque Reservoir and the Cedar Grove treatment plant in Newark had 0.14 and 0.07 pCi/L,

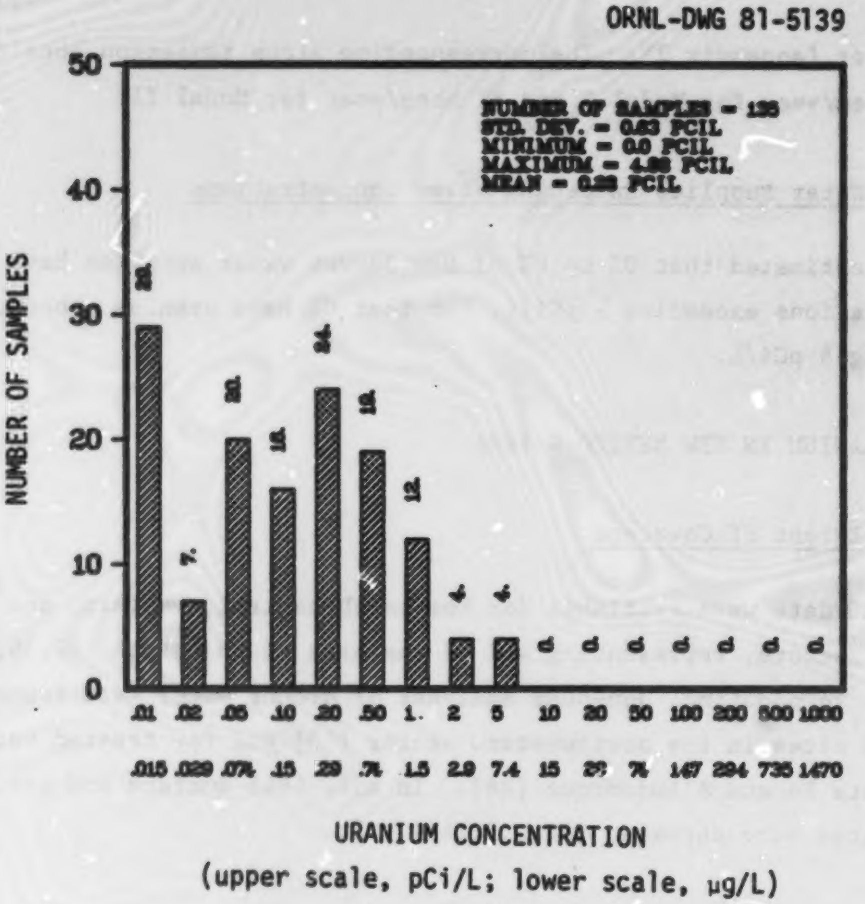


Fig. 3.115. Histogram of uranium concentrations in domestic waters of New Jersey.

respectively. In nearby Paterson, the concentrations of uranium in samples from the Wanaque Reservoir and the Little Falls treatment plant were similar: 0.14 and <0.07 pCi/L, respectively. In a more recent analysis of water composited from the Trenton municipal system between July and December, 1977, analysts at the Office of Radiation Programs detected 0.021, 0.003, and 0.013 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively [1]. The uranium activity in this sample totaled 0.037 pCi/L.

### 3.31.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in New Jersey domestic water was estimated as 0.1 pCi/L, 16th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 2 mrem/year for Model I and <1 mrem/year for Model II.

### 3.31.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% to 6% of New Jersey water supplies have uranium concentrations exceeding 1 pCi/L, but that 0% have uranium concentrations exceeding 5 pCi/L.

## 3.32 URANIUM IN NEW MEXICO WATERS

### 3.32.1 Extent of Coverage

NURE data were available for the north-central, western, and southeastern sectors, representing 45% of the area of the state [27,56,57,59, 63,64]. In addition, non-NURE analyses of ground water were found for selected sites in the northwestern sector [15] and for treated waters from Santa Fe and Albuquerque [26]. In all, 4948 surface and ground water sites were surveyed (Fig. 3.116).

### 3.32.2 Concentrations of Uranium in Samples

3.32.2.1 Surface Waters — The concentrations of uranium in 1142 New Mexico surface waters ranged from 0.01 pCi/L to 234.44 pCi/L and averaged 2.01 pCi/L. The median and modal concentration ranges were identical, 0.2 to 0.5 pCi/L (Fig. 3.117).

3.32.2.2 Ground Waters — A total of 3806 New Mexico ground water samples were analyzed. Uranium in these samples ranged from 0.01 to 464.17 pCi/L and averaged 3.45 pCi/L. The median concentration range was 1 to 2 pCi/L, and the modal range was 2 to 5 pCi/L (Fig. 3.118).

3.32.2.3 Established Domestic and Municipal Waters — One hundred two New Mexico sites were identified as domestic water sources. Uranium in these waters ranged from 0.04 to 45.35 pCi/L and averaged 2.99 pCi/L. The median and modal concentration ranges of these samples were 1 to 2 pCi/L and 2 to 5 pCi/L, respectively (Fig. 3.119).

ORNL-DWG 81-5231

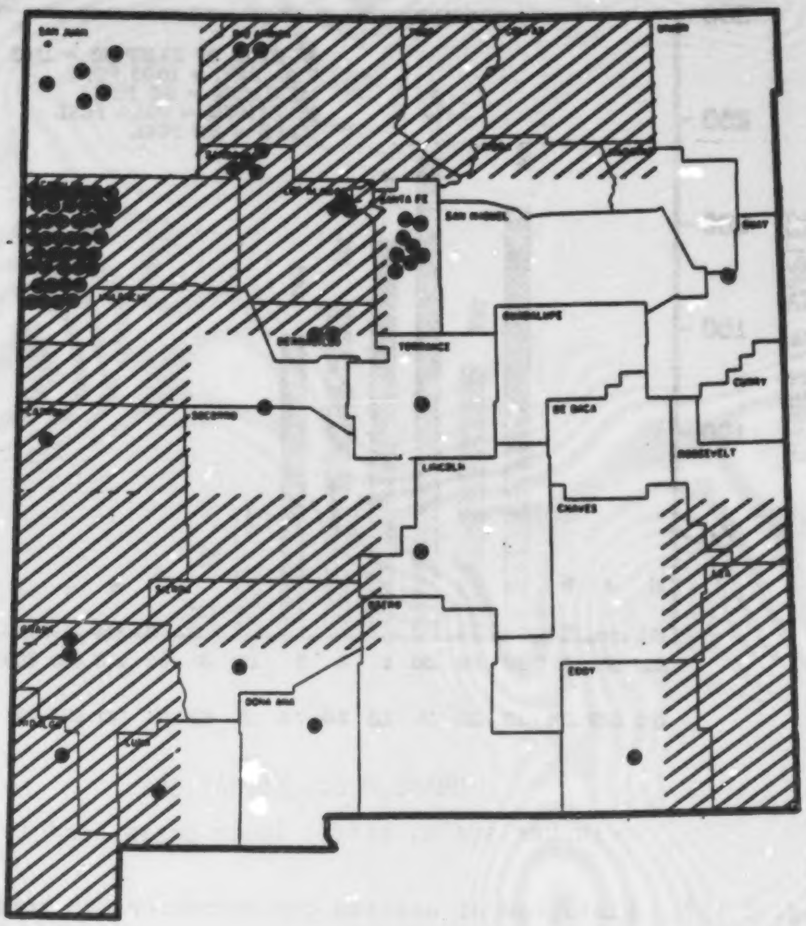

SAN JUAN
SANTA FE
SAN MIGUEL
QUAY
GUADALUPE
TORRANCE
CURRY
DE BACA
ROOSEVELT
SOCORRO
LINCOLN
CHAVES
OTERO
DONA ANA
EDDY
LEA
GRANT
HIDALGO
LUNA

Fig. 3.116. Locations of sample sites in New Mexico.

3.32.2.4 Treated Waters from Municipal Water Purification Plants — In 1961, water from the West Mesa, Santa Barbara, and Eubank stations in Albuquerque contained 6.7, 3.2, and 2.0 pCi/L uranium, respectively (Durfor and Becker [26]). The West Mesa station, which contained the highest concentration of uranium, supplied 4% of the total water consumed in the city. The Santa Barbara and Eubank stations furnished 34% and 50%, respectively. More recently, the Office of Radiation Programs [1] analyzed a sample of water, composited from July to December, 1977, from the Santa Fe municipal system. It contained 0.221, 0.002, and 0.080 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total uranium activity of this sample was 0.303 pCi/L.

ORNL-DWG 81-5140

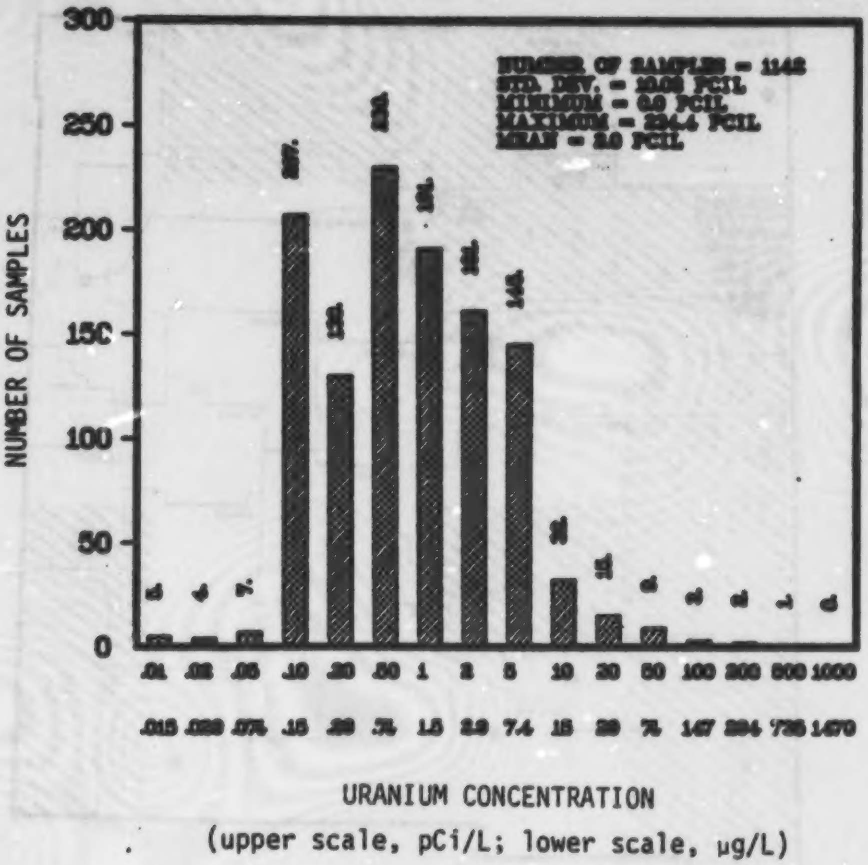


Fig. 3.117. Histogram of uranium concentrations in surface waters of New Mexico.

### 3.32.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in New Mexico domestic waters was estimated to be 2.9 pCi/L, 3d highest among all states (Appendix 2). The corresponding alpha radiation bone doses were 44 mrem/year for Model I and 2 mrem/year for Model II.

Sources of uranium contamination in New Mexico waters are not hard to find. New Mexico contains the most extensive proven uranium deposits in the United States [64]. Most of the mining activity occurs in the Ambrosia Lake and Laguna mining districts within the Grants Mineral Belt. Ground waters associated with these deposits naturally contain elevated

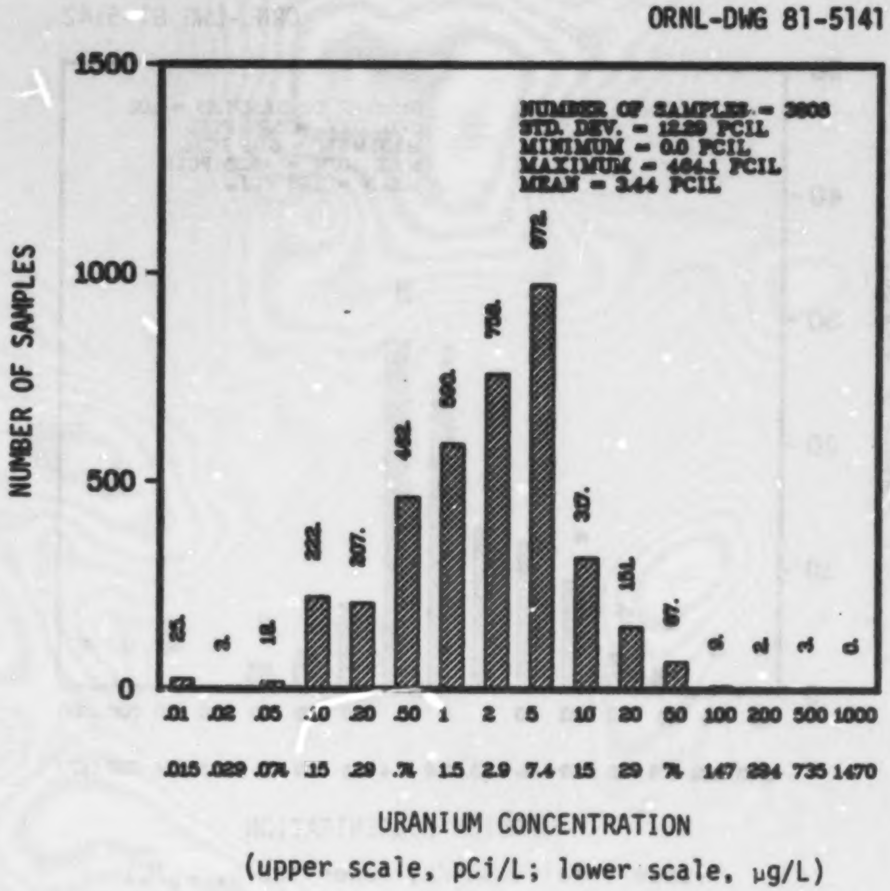


Fig. 3.118. Histogram of uranium concentrations in ground waters of New Mexico.

concentrations of uranium. Surface waters may also reflect contact with naturally occurring uranium deposits as well as seepage from tailings ponds and accidental releases of mining waters and solid wastes.

### 3.32.4 Water Supplies Exceeding Given Concentrations

Based upon the data collected in this study we estimated that 43% to 62% of the New Mexico water supplies have uranium concentrations exceeding 1 pCi/L; 0% to 12%, exceeding 5 pCi/L; 0% to 5%, exceeding 10 pCi/L; and 0% to 2%, exceeding 20 pCi/L.

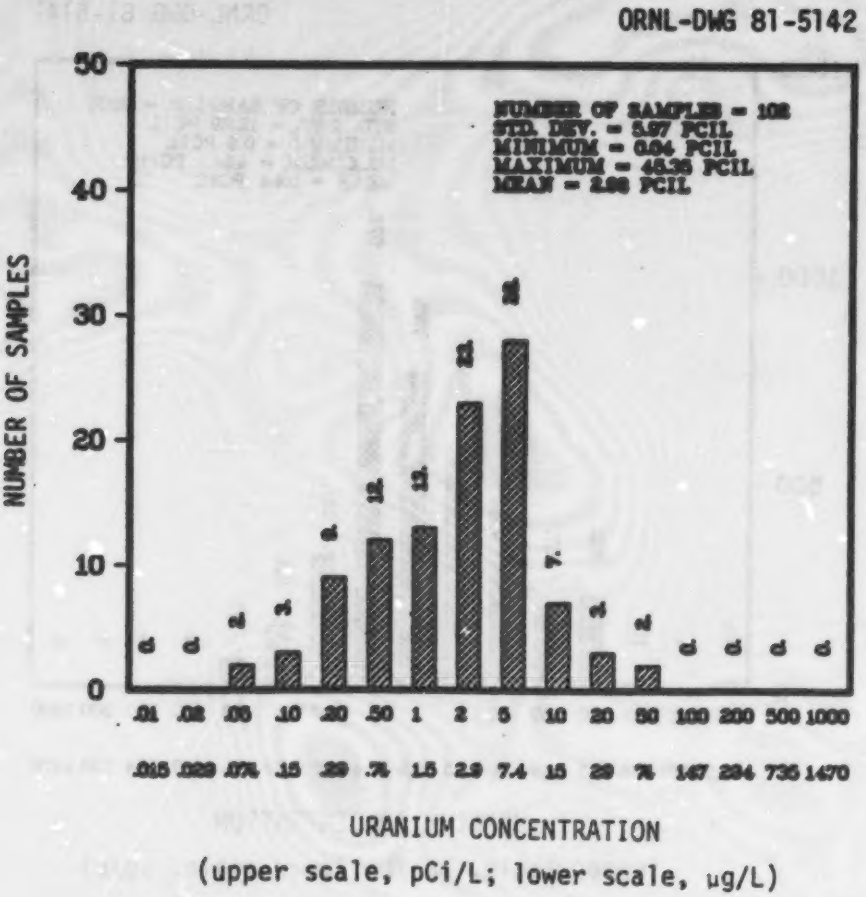


Fig. 3.119. Histogram of uranium concentrations in domestic waters of New Mexico.

## 3.33 URANIUM IN NEW YORK WATERS

### 3.33.1 Extent of Coverage

NURE data have been reported for about 25% of the state, chiefly the southeastern sector [74,79,81,82]. Non-NURE analyses were available for a few additional sites, including water treatment plants serving six of the state's largest cities [26]. In all, 2546 surface and ground water sources were surveyed (Fig. 3.120).

ORNL-DWG 81-5232

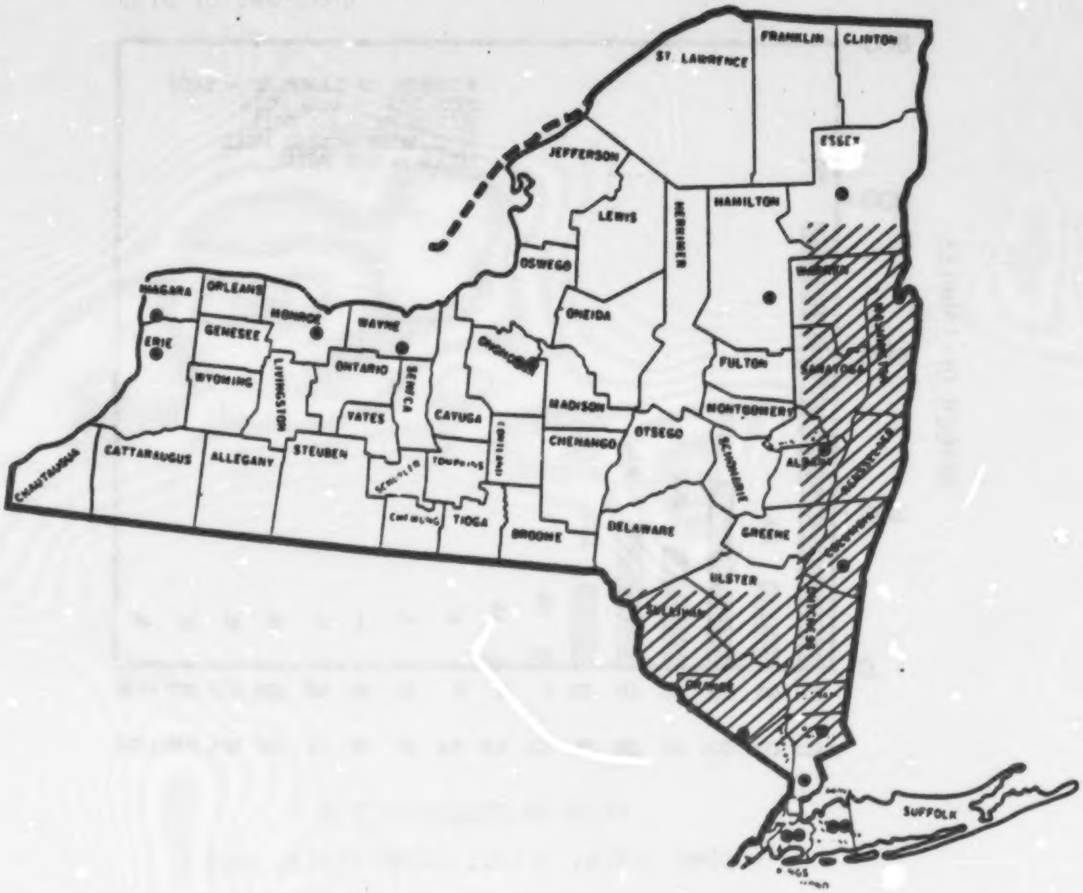

FRANKLIN
CLINTON
ST. LAWRENCE
ESSEX
JEFFERSON
LEWIS
HERKIMER
HAMILTON
WARREN
OSWEGO
ONEIDA
WASHINGTON
NIAGARA
ORLEANS
MONROE
WAYNE
GENESEE
ERIE
ONONDAGA
LIVINGSTON
ONTARIO
SENECA
FULTON
SARATOGA
WYOMING
YATES
CAYUGA
MADISON
MONTGOMERY
CORTLAND
CHENANGO
OTSEGO
SCHOHARIE
ALBANY
RENSSELAER
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
SCHUYLER
TOMPKINS
CHEMUNG
TIOGA
BROOME
DELAWARE
GREENE
COLUMBIA
ULSTER
SULLIVAN
DUTCHESS
ORANGE
SUFFOLK
KINGS

Fig. 3.120. Locations of sample sites in New York.

### 3.33.2 Concentrations of Uranium in Samples

3.33.2.1 Surface Waters — For New York 1404 surface water analyses were recorded. The concentrations of uranium in these samples ranged from 0.01 to 10.41 pCi/L and averaged 0.12 pCi/L. The median concentration range was 0.02 to 0.05 pCi/L, but the mode was somewhat lower, 0.01 pCi/L (Fig. 3.121).

3.33.2.2 Ground Waters — There were 1142 New York ground water analyses. Uranium in these samples varied from 0.01 to 18.66 pCi/L and averaged 0.47 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L and 0.02 to 0.05 pCi/L, respectively (Fig. 3.122).

ORNL-DWG 81-5143

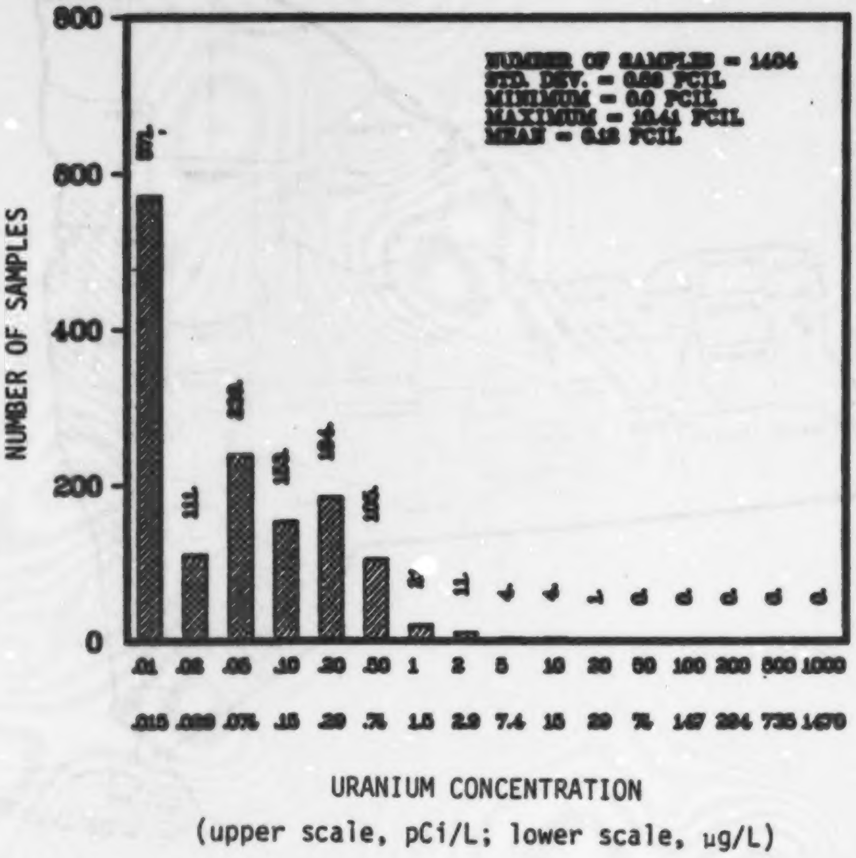


Fig. 3.121. Histogram of uranium concentrations in surface waters of New York.

3.33.2.3 Established Domestic and Municipal Waters — Of the New York sites 1109 were identified as domestic water sources. The concentrations of uranium in these samples ranged from 0.01 to 18.66 pCi/L and averaged 0.45 pCi/L. The most frequently occurring concentration range was 0.02 to 0.05 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L (Fig. 3.123).

3.33.2.4 Treated Waters from Municipal Water Purification Plants — In 1961 the concentrations of uranium in treated waters from all listed New York municipal systems were low. Outputs from the Lake Ontario filter plant and the Upland Supply station in Rochester, the Feura Bush

ORNL-DWG 81-5144

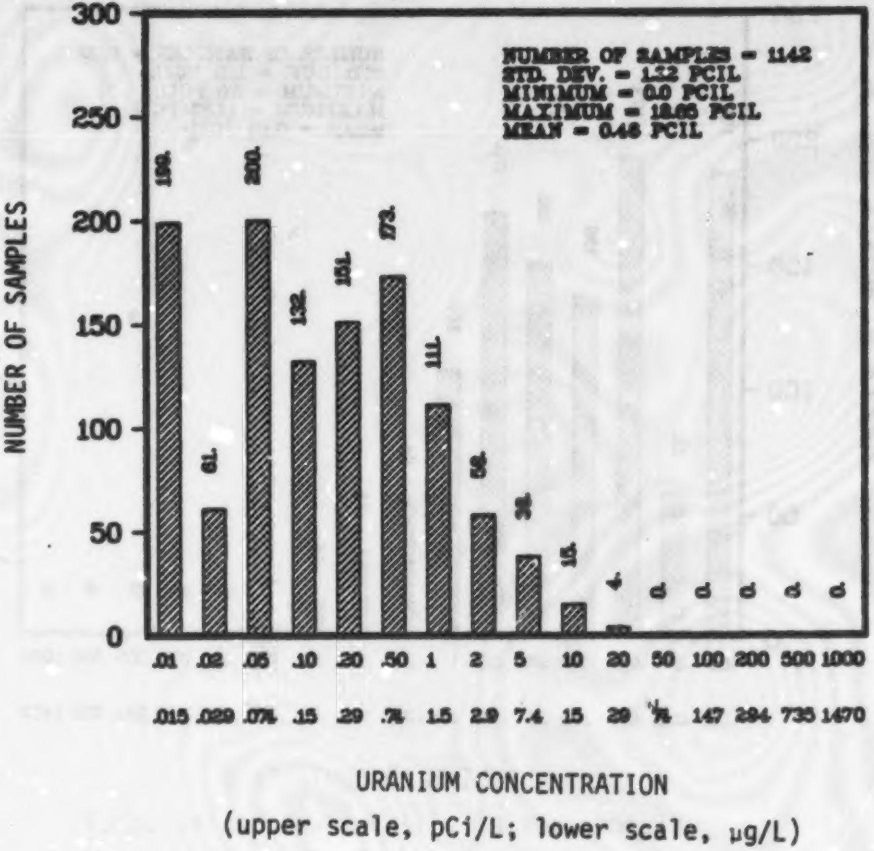
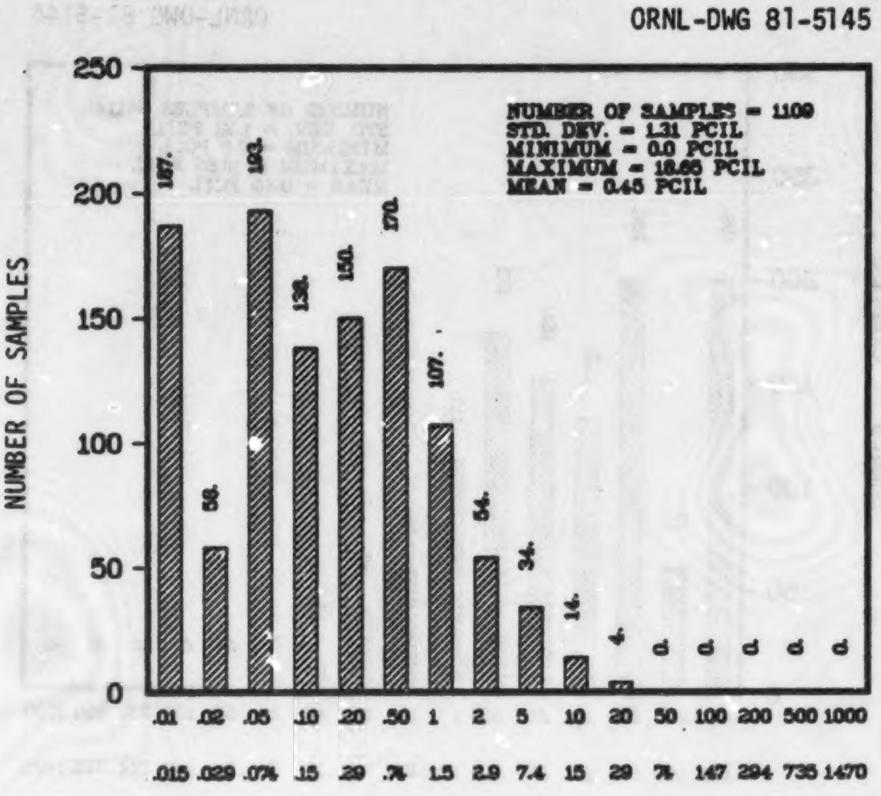


Fig. 3.122. Histogram of uranium concentrations in ground waters of New York.

filter plant in Albany, and the Skaneateles Lake station in Syracuse were at or below the limit of detection, 0.07 pCi/L. Water from the Saw Mill Reservior, the Grassy Sprain Reservoir, and the Catskill Aqueduct in Yonkers contained 0.2, 0.07, and 0.07 pCi/L uranium, respectively. In the New York City system, finished water from the Catskill and Delaware supplies, the Croton supply, and the Jamaica Wells station contained 0.14, 0.14, and 0.68 pCi/L uranium, respectively. The Buffalo filtration plant sample contained 0.14 pCi/L uranium.

More recent analyses of water from New York and Buffalo indicate little change in the uranium concentrations in finished water from these



URANIUM CONCENTRATION
(upper scale, pCi/L; lower scale, µg/L)

Fig. 3.123. Histogram of uranium concentrations in domestic waters of New York.

cities. A July 1974 to June 1975 composite of water from the New York system contained 0.010, 0.001, and 0.005 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$ [2]. Total uranium activity of this sample was 0.016 pCi/L. Similarly, a July 1976 to June 1977 composite sample from the Buffalo system contained 0.153, 0.005, and 0.113 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively [201]. The total uranium activity in this sample was 0.271 pCi/L.

### 3.33.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in New York domestic water was estimated to be 0.3 pCi/L, 14th highest among all states. The corresponding alpha radiation bone dose was 4 mrem/year for Model I and <1 mrem/year for Model II.

### 3.33.4 Water Supplies Exceeding Given Concentrations

We estimated that 9% to 10% of New York water supplies contain uranium in excess of 1 pCi/L; 0% to 2%, in excess of 5 pCi/L; 0% to 0.4%, in excess of 10 pCi/L; and 0%, in excess of 20 pCi/L.

## 3.34 URANIUM IN NORTH CAROLINA WATERS

### 3.34.1 Extent of Coverage

Systematic surveys for uranium in water have been reported for approximately one-half of North Carolina. Essentially all of the area west of 80° W. longitude is included, as well as counties in the north-central and southeastern sectors [66,67,70,73,85,101]. A few additional selected samples were also available, including processed waters from municipal water purification plants in the two largest cities of the state [15,26]. Overall, data were recorded for 1919 surface and ground water sites (Fig. 3.124).

ORNL-DWG 81-5233

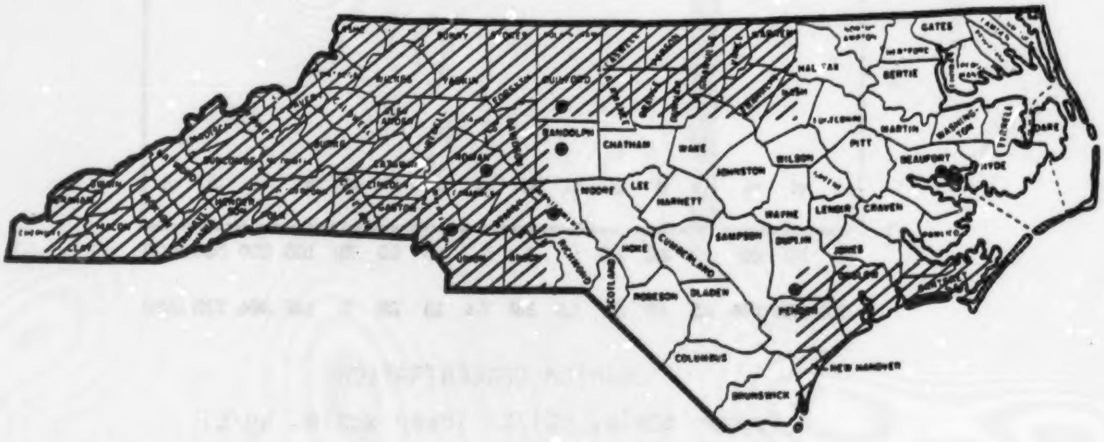

SURRY
STOKES
GATES
HALIFAX
BERTIE
WILKES
YADKIN
FORSYTH
GUILFORD
RANDOLPH
CHATHAM
WAKE
JOHNSTON
WILSON
PITT
MARTIN
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
BURKE
ROWAN
MOORE
LEE
HARNETT
WAYNE
LENOIR
CRAVEN
SAMPSON
DUPLIN
JONES
HOKE
CUMBERLAND
RICHMOND
SCOTLAND
ROBESON
BLADEN
PENDER
COLUMBUS
NEW HANOVER
BRUNSWICK
UNION
MACON

Fig. 3.124. Locations of sample sites in North Carolina.

### 3.34.2 Concentrations of Uranium in Samples

3.34.2.1 Surface Waters — Only two of the recorded North Carolina samples were surface water. The concentrations of uranium in both samples were low, 0.07 pCi/L (Fig. 3.125).

3.34.2.2 Ground Waters — Almost all (1917) of the recorded North Carolina samples were ground water. The concentrations of uranium in these samples ranged 0.01 to 88.60 pCi/L and averaged 0.29 pCi/L. Median and modal concentration ranges were 0.02 to 0.05 pCi/L (Fig. 3.126).

3.34.2.3 Established Domestic and Municipal Waters — Of the sites in North Carolina 1444 were considered domestic or municipal sources.

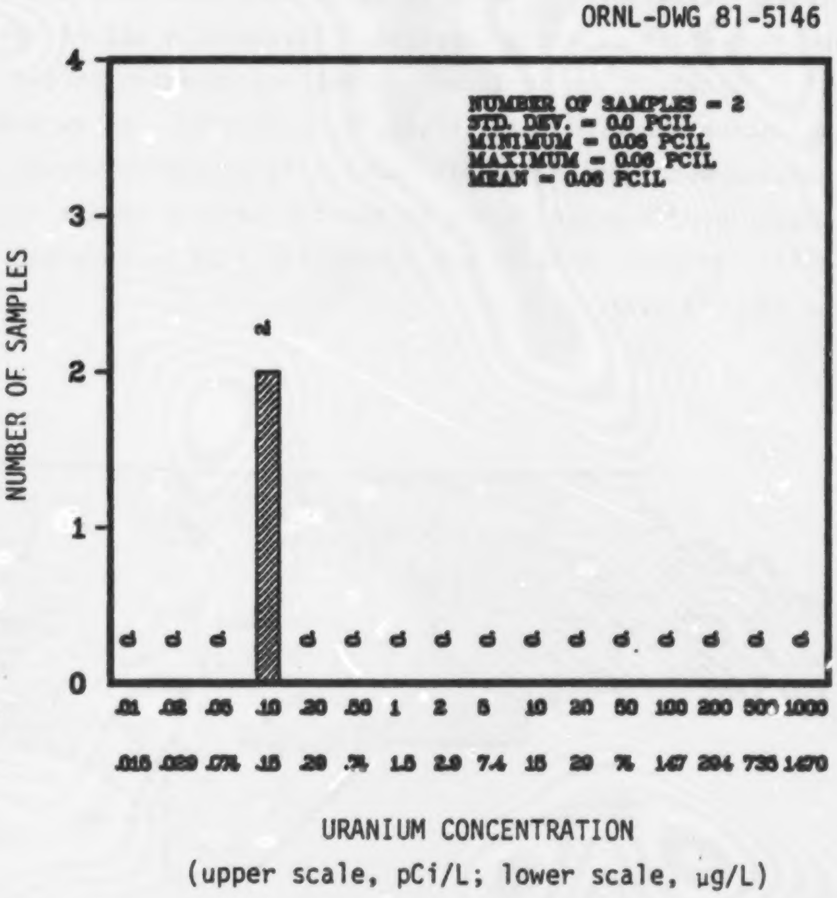


Fig. 3.125. Histogram of uranium concentrations in surface waters of North Carolina.

ORNL-DWG 81-5147

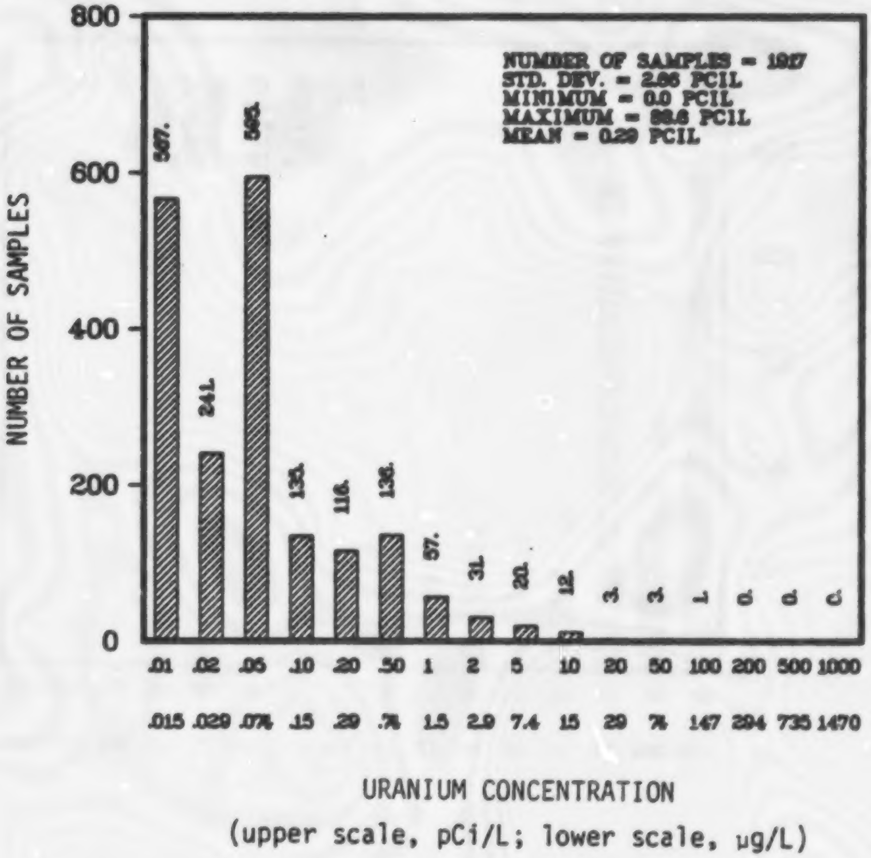


Fig. 3.126. Histogram of uranium concentrations in ground waters of North Carolina.

The concentrations of uranium in water from these sources ranged from 0.01 to 88.60 pCi/L and averaged 0.29 pCi/L. The median concentration range was 0.02 to 0.05 pCi/L, and the mode was 0.01 pCi/L (Fig. 3.127).

3.34.2.4 Treated Waters from Municipal Water Purification Plants — Water from the Hoskins treatment plant in Charlotte and from Lake Brandt treatment plant in Greensboro contained only 0.07 pCi/L uranium in 1961.

### 3.34.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in North Carolina domestic waters was estimated as <0.1 pCi/L, 17th highest among

ORNL-DWG 81-5148

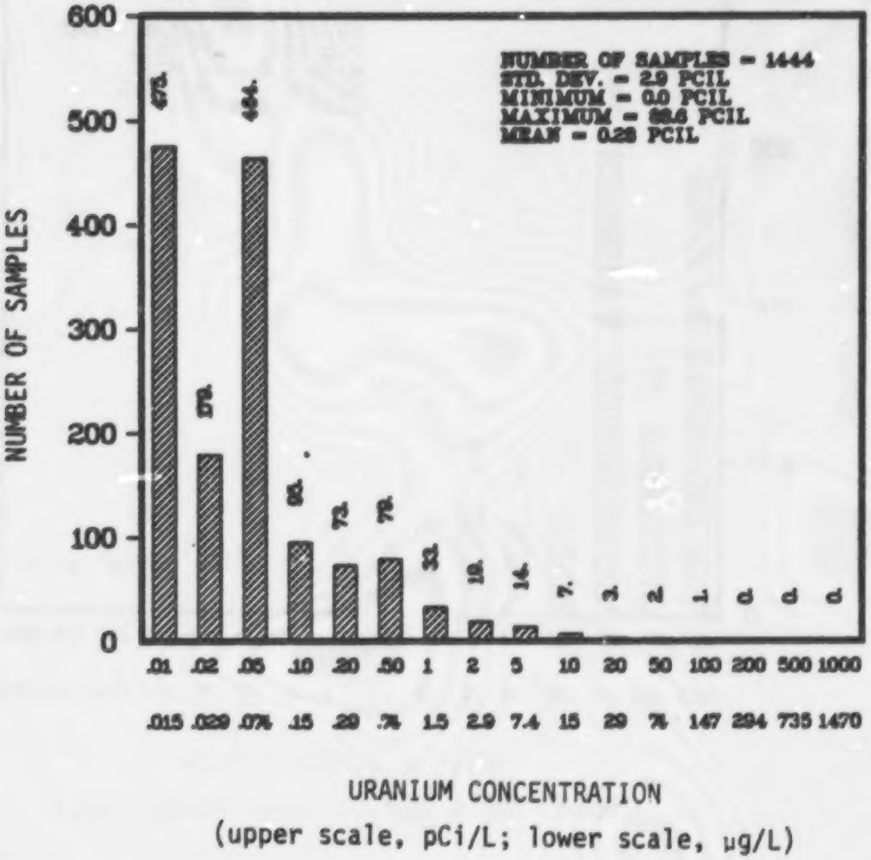


Fig. 3.127. Histogram of uranium concentrations in domestic waters of North Carolina.

all states. The alpha radiation bone dose based on this average was 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.34.4 Water Supplies Exceeding Given Concentrations

Based on the data collected in this study we estimated that 0% to 3% of North Carolina water supplies have uranium in excess of 1 pCi/L; 0% to 0.9%, in excess of 5 pCi/L; 0% to 0.4%, in excess of 10 pCi/L; and 0% to 0.2%, in excess of 20 pCi/L.

## 3.35 URANIUM IN NORTH DAKOTA WATERS

### 3.35.1 Extent of Coverage

No NURE analyses were available for North Dakota waters when this report was prepared. However, data were found for selected samples from the Bismarck municipal water system [26] and for a few additional locations randomly distributed throughout the state [15]. Overall, nine surface and ground water sites were surveyed (Fig. 3.128).

### 3.35.2 Concentrations of Uranium in Samples

3.35.2.1 Surface Waters — Data were available for only one North Dakota surface water sample. It contained 0.12 pCi/L uranium.

3.35.2.2 Ground Waters — There were eight North Dakota ground water analyses. The concentrations of uranium in these samples ranged from 0.07 to 0.68 pCi/L and averaged 0.28 pCi/L. The median and modal concentration ranges for this subset were identical, 0.2 to 0.5 pCi/L (Fig. 3.129).

ORNL-DWG 81-5234

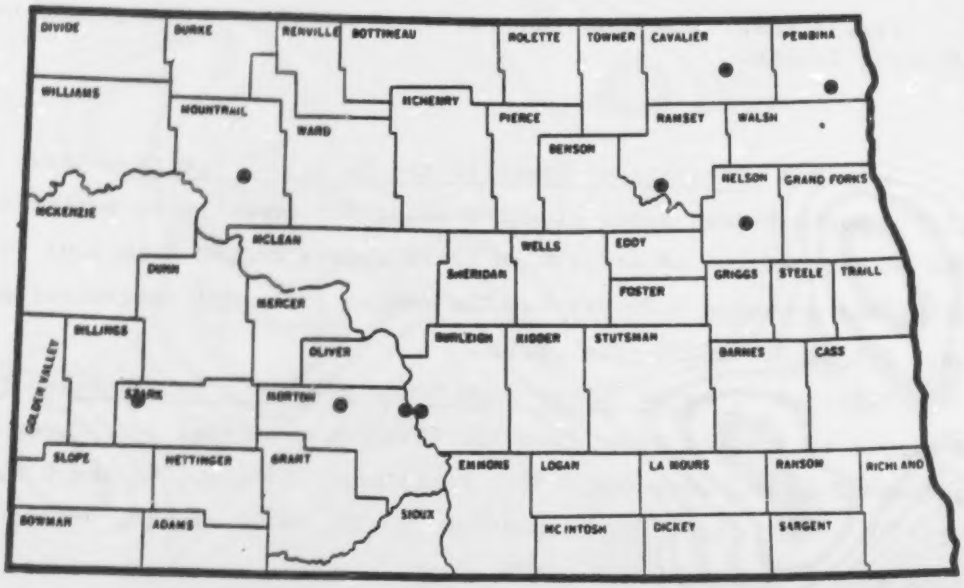

DIVIDE
BURKE
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
WILLIAMS
MOUNTRAIL
MCHENRY
WARD
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
MCKENZIE
MCLEAN
WELLS
EDDY
DUNN
SHERIDAN
GRIGGS
STEELE
TRAILL
FOSTER
MERCER
BILLINGS
BURLEIGH
KIDDER
STUTSMAN
BARNES
CASS
OLIVER
GOLDEN VALLEY
STARK
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LA MOURE
RANSOM
RICHLAND
SIOUX
BOWMAN
ADAMS
MC INTOSH
DICKEY
SARGENT

Fig. 3.128. Locations of sample sites in North Dakota.

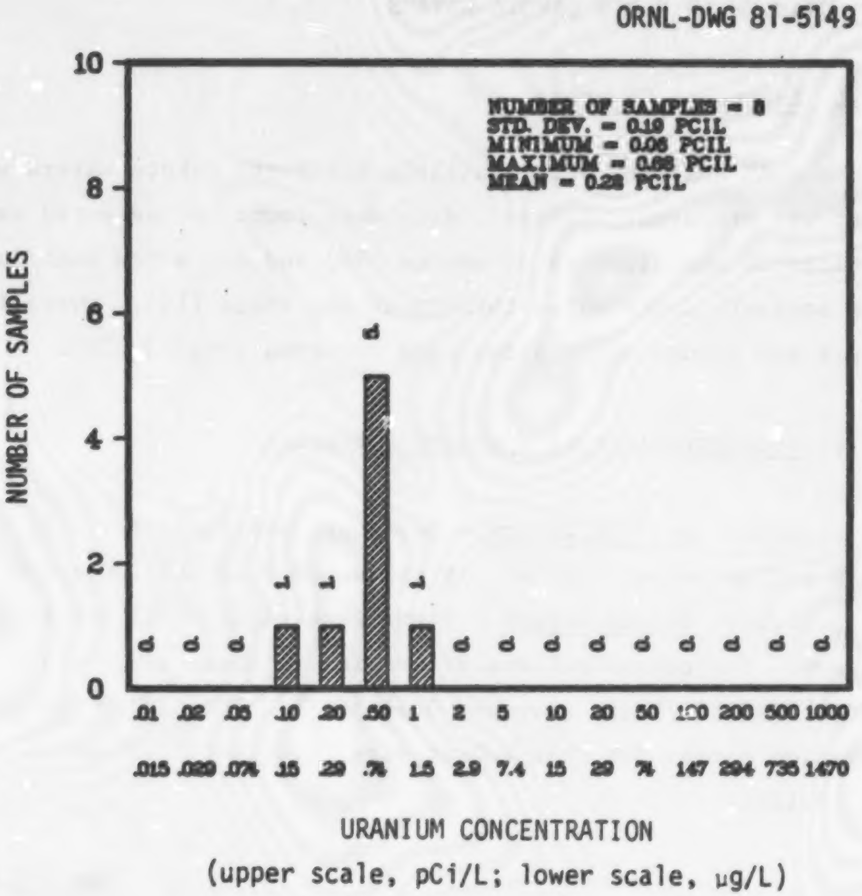


Fig. 3.129. Histogram of uranium concentrations in ground waters of North Dakota.

3.35.2.3 Established Domestic and Municipal Waters — Seven of the listed North Dakota sites produced water for domestic or municipal use. The concentrations of uranium in these waters ranged from 0.07 to 0.68 pCi/L and averaged 0.26 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.130).

3.35.2.4 Treated Waters from Municipal Water Purification Plants — A sample of treated water from the Bismarck municipal system, composited between July and December, 1977, contained 0.065, 0.004, and 0.054 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total uranium activity of this sample equaled 0.123 pCi/L.

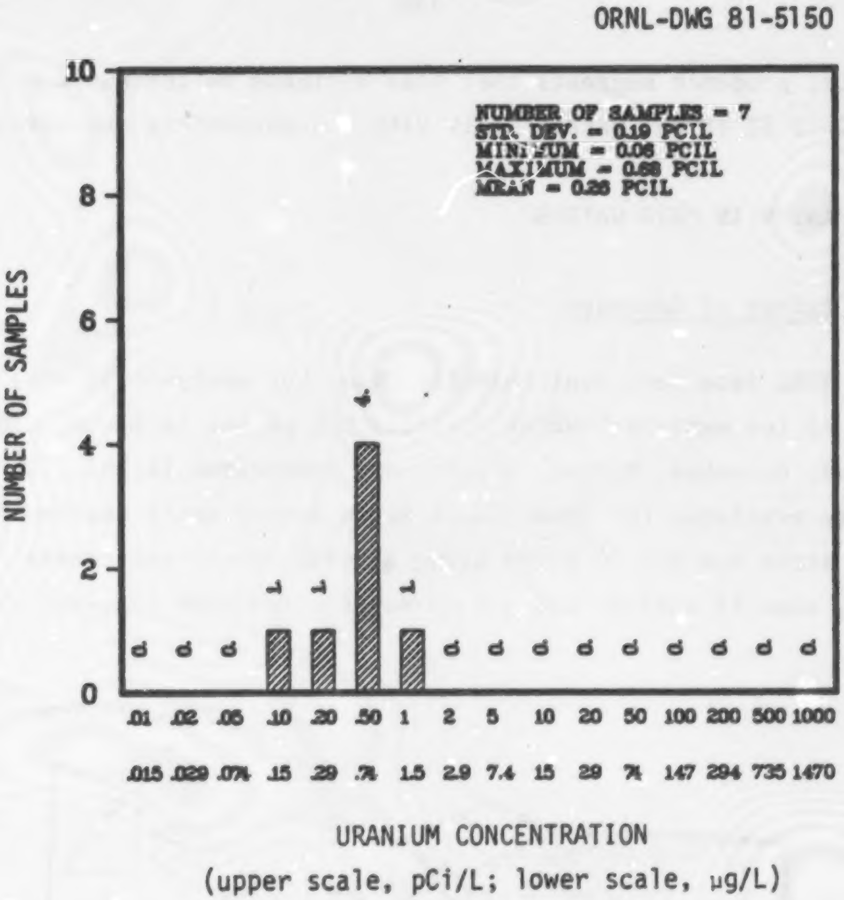


Fig. 3.130. Histogram of uranium concentrations in domestic waters of North Dakota.

### 3.35.3 Population-Weighted Average Concentration

Based on very limited data, we estimated the population-weighted average concentration of uranium in North Dakota domestic waters to be 0.3 pCi/L, 14th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 5 mrem/year for Model I and <1 mrem/year for Model II.

### 3.35.4 Water Supplies Exceeding Given Concentrations

Based on very limited data we estimated that no North Dakota water supply has uranium in excess of 1 pCi/L. However, until more data are available, prudence suggests that this estimate be increased to at least 0% to 5% of the water supply with concentrations exceeding 1 pCi/L.

## 3.36 URANIUM IN OHIO WATERS

### 3.36.1 Extent of Coverage

No NURE data were available for Ohio, but analyses of treated water were found for municipal water purification plants in Akron, Cincinnati, Cleveland, Columbus, Dayton, Toledo, and Youngstown [1,26]. In addition, data were available for more than a dozen county seats scattered throughout the state and for 40 sites along several rivers and creeks [11,15]. Overall, some 85 surface and ground water sites were surveyed (Fig. 3.131).

ORNL-DWG 81-5235

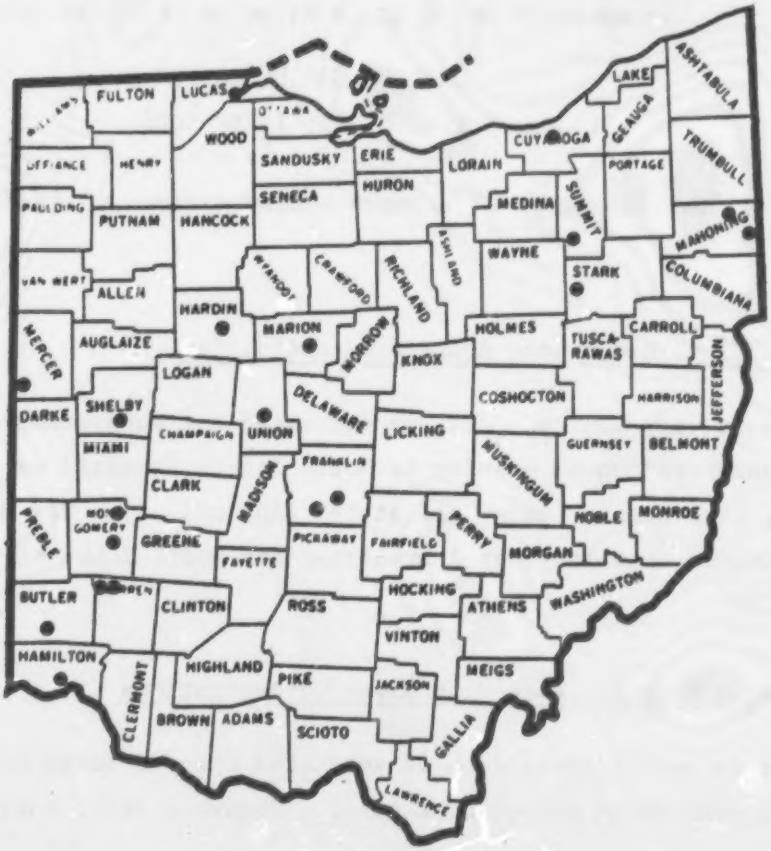

WILLIAMS
FULTON
LUCAS
OTTAWA
WOOD
DEFIANCE
HENRY
SANDUSKY
ERIE
LORAIN
CUYAHOGA
LAKE
GEAUGA
ASHTABULA
TRUMBULL
PORTAGE
SUMMIT
MEDINA
HURON
SENECA
PAULDING
PUTNAM
HANCOCK
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
WAYNE
STARK
MAHONING
COLUMBIANA
VAN WERT
ALLEN
HARDIN
MARION
MORROW
HOLMES
TUSCA-RAWAS
CARROLL
MERCER
AUGLAIZE
LOGAN
KNOX
COSHOCTON
HARRISON
JEFFERSON
DARKE
SHELBY
CHAMPAIGN
UNION
DELAWARE
LICKING
MUSKINGUM
GUERNSEY
BELMONT
MIAMI
CLARK
MADISON
FRANKLIN
PREBLE
MONT-GOMERY
GREENE
FAYETTE
PICKAWAY
FAIRFIELD
PERRY
NOBLE
MONROE
MORGAN
BUTLER
WARREN
CLINTON
ROSS
HOCKING
ATHENS
WASHINGTON
VINTON
HAMILTON
CLERMONT
HIGHLAND
PIKE
JACKSON
MEIGS
BROWN
ADAMS
SCIOTO
GALLIA
LAWRENCE

Fig. 3.131. Locations of sample sites in Ohio.

### 3.36.2 Concentrations of Uranium in Samples

3.36.2.1 Surface Waters — Uranium in 75 Ohio surface waters ranged from 0.07 to 1.16 pCi/L and averaged 0.46 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L (Fig. 3.132).

3.36.2.2 Ground Waters — Uranium concentrations in ten Ohio ground water samples varied from 0.07 to 1.36 pCi/L uranium and averaged 0.75 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L and 1 to 2 pCi/L, respectively (Fig. 3.133).

3.36.2.3 Established Domestic and Municipal Waters — Seventeen of the listed Ohio sites were identified as domestic or municipal water

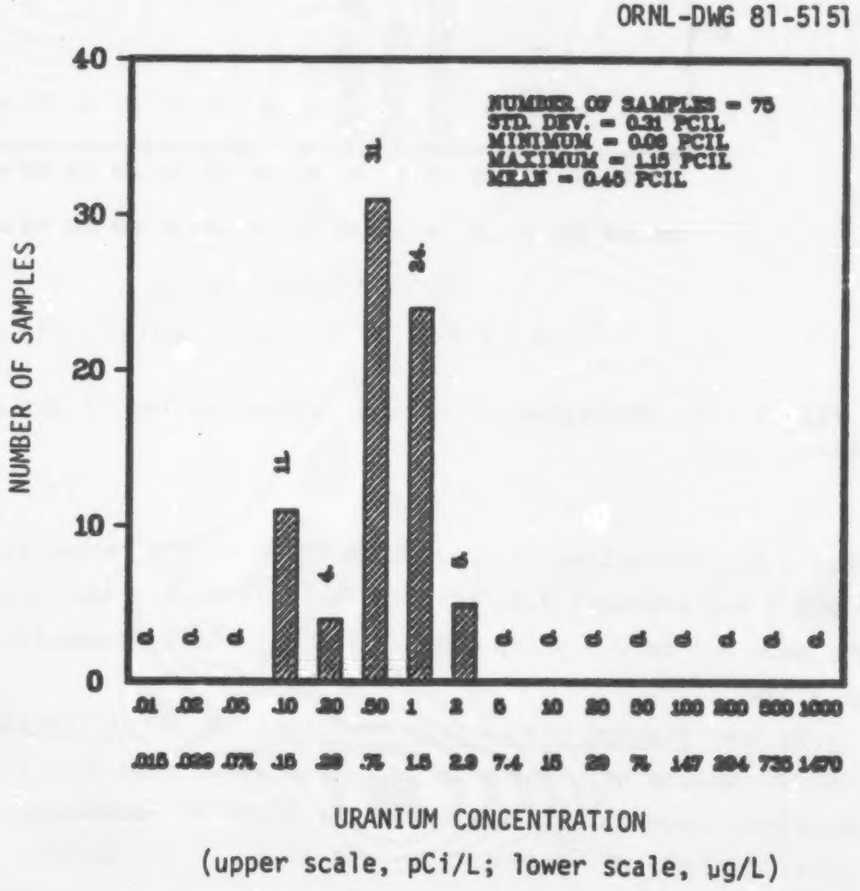


Fig. 3.132. Histogram of uranium concentrations in surface waters of Ohio.

ORNL-DWG 81-5152

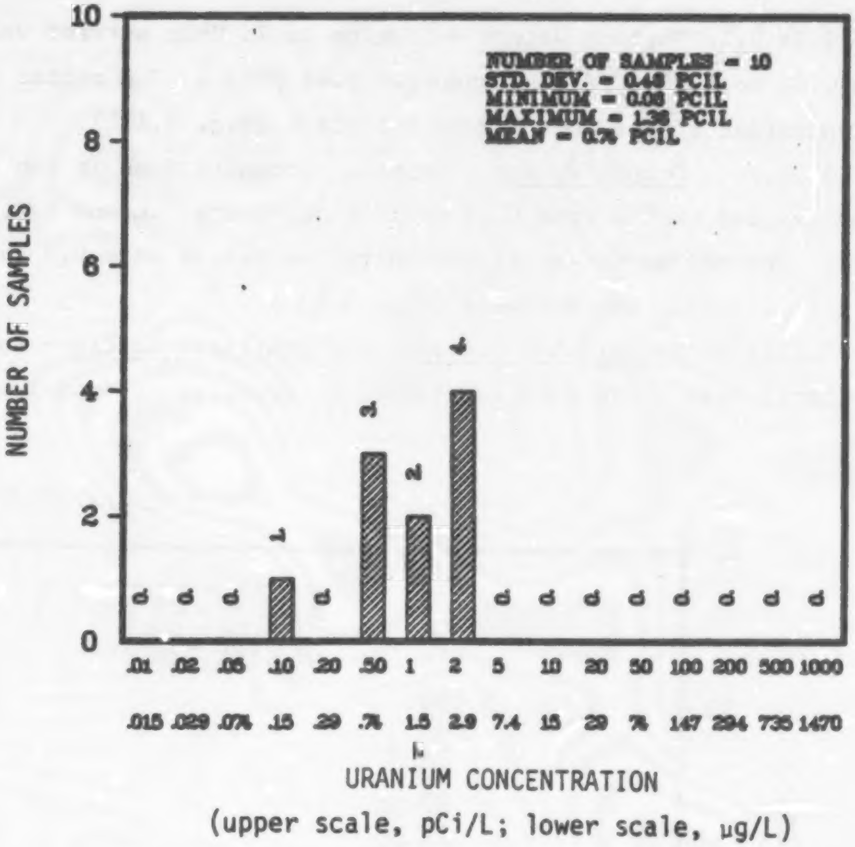


Fig. 3.133. Histogram of uranium concentrations in ground waters of Ohio.

sources. Concentrations of uranium in these waters ranged from 0.07 to 1.36 pCi/L and averaged 0.42 pCi/L. The median and modal concentration ranges were 0.2 to 0.5 pCi/L and 0.05 to 0.1 pCi/L, respectively (Fig. 3.134).

3.36.2.4 Treated Waters from Municipal Water Purification Plants — The concentrations of uranium in processed water from Ohio's seven largest metropolitan areas in 1962 were near the limit of detection: Akron, 0.07; Cincinnati, <0.07; Cleveland, 0.20; Columbus, <0.07; Dayton, <0.07; Toledo, 0.07; and Youngstown, 0.07 pCi/L. A more recent sample from Columbus, composited between July and December, 1977, indicated that little change had occurred in the uranium concentration of treated water

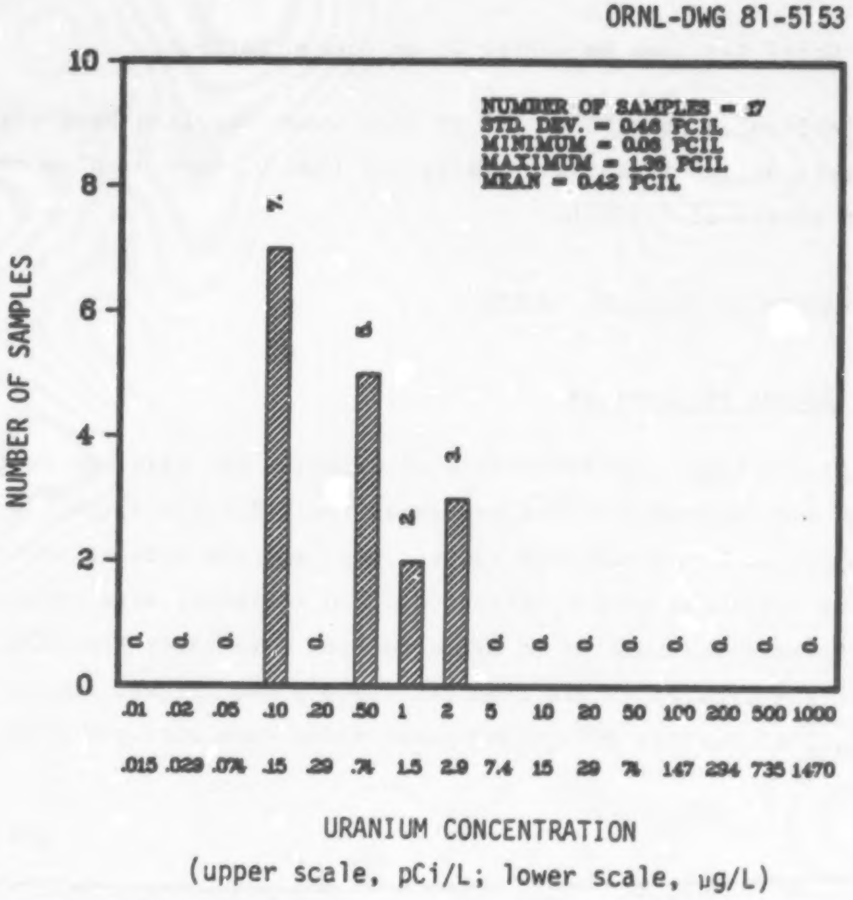


Fig. 3.134. Histogram of uranium concentrations in domestic waters of Ohio.

from that city since the 1962 analysis was made. The 1977 sample contained 0.035, 0.002, and 0.028 pCi/L uranium. The total activity due to uranium was 0.065 pCi/L, in good agreement with the 1962 analysis.

### 3.36.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Ohio domestic water was estimated to be <0.1 pCi/L, 17th highest among all states (Appendix 2). The corresponding alpha radiation bone dose estimate was 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.36.4 Water Supplies Exceeding Given Concentrations

We estimated that 9% to 18% of Ohio water supplies have uranium concentrations in excess of 1 pCi/L, but that 0% have uranium concentrations in excess of 5 pCi/L.

## 3.37 URANIUM IN OKLAHOMA WATERS

### 3.37.1 Extent of Coverage

A little less than two-thirds of Oklahoma has been systematically surveyed and reported by NURE personnel [98,112,120,123,129,130]; only those counties lying near the eastern edge and the extreme northwest corner of the state remain unreported. In addition, data were available for a few selected samples in areas not yet covered by the NURE program [15] and for treated waters from the state's two largest cities [26]. Overall, 3447 surface and ground water sites were surveyed (Fig. 3.135).

ORNL-DWG 81-5236

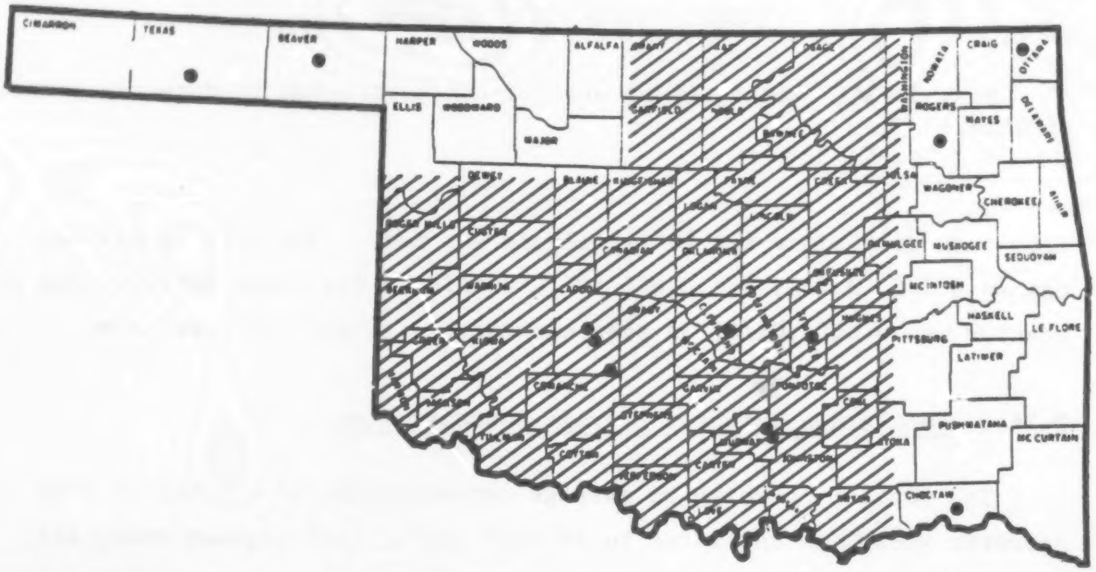

CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
ELLIS
WOODWARD
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DELAWARE
DEWEY
BLAINE
KINGFISHER
PAYNE
CREEK
TULSA
WAGONER
CHEROKEE
ADAIR
ROGER MILLS
CUSTER
LOGAN
LINCOLN
CANADIAN
OKLAHOMA
OKMULGEE
MUSKOGEE
SEQUOYAH
BECKHAM
WASHITA
CADDO
OKFUSKEE
MC INTOSH
GRADY
HUGHES
HASKELL
LE FLORE
GREER
KIOWA
PITTSBURG
LATIMER
JACKSON
COMANCHE
GARVIN
PONTOTOC
COAL
STEPHENS
PUSHMATAHA
TILLMAN
COTTON
MURRAY
ATOKA
MC CURTAIN
JEFFERSON
CARTER
JOHNSTON
LOVE
BRYAN
CHOCTAW

Fig. 3.135. Locations of sample sites in Oklahoma.

### 3.37.2 Concentrations of Uranium in Samples

3.37.2.1 Surface Waters — Uranium analyses were available for only two Oklahoma surface water samples. In each, the concentration of uranium was low: 0.14 and 0.20 pCi/L (Fig. 3.136).

3.37.2.2 Ground Waters — Thirty-four hundred forty-five Oklahoma ground water analyses were found. Uranium in these samples ranged from 0.01 to 120.15 pCi/L and averaged 4.57 pCi/L. The modal concentration range was only 0.1 to 0.2 pCi/L, but the median concentration range was an order of magnitude higher, 1 to 2 pCi/L (Fig. 3.137).

ORNL-DWG 81-5154

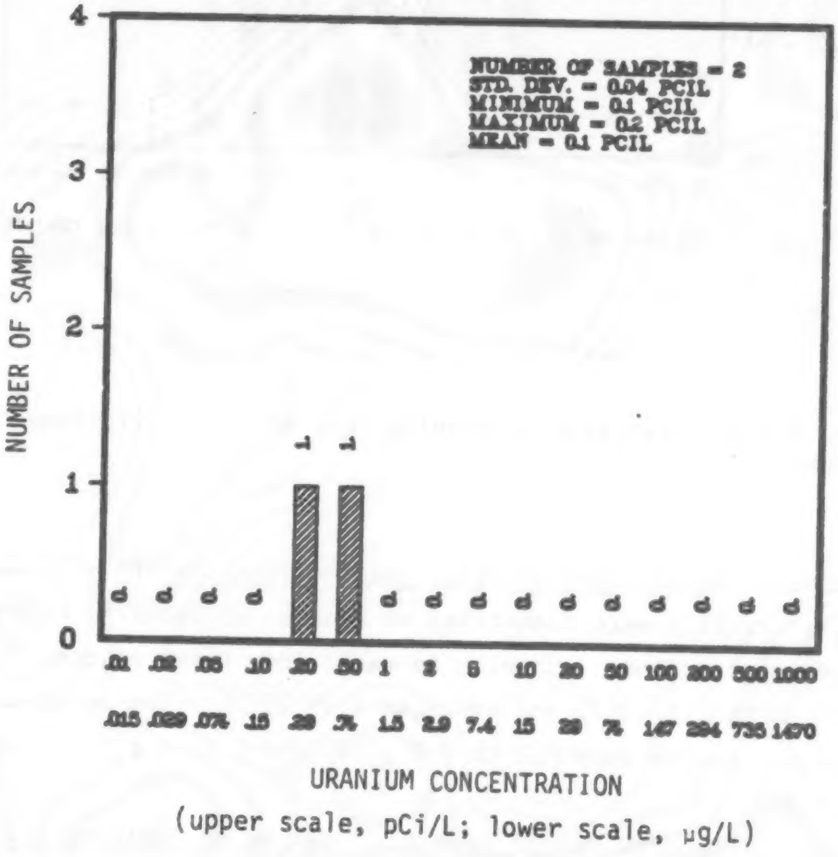


Fig. 3.136. Histogram of uranium concentrations in surface waters of Oklahoma.

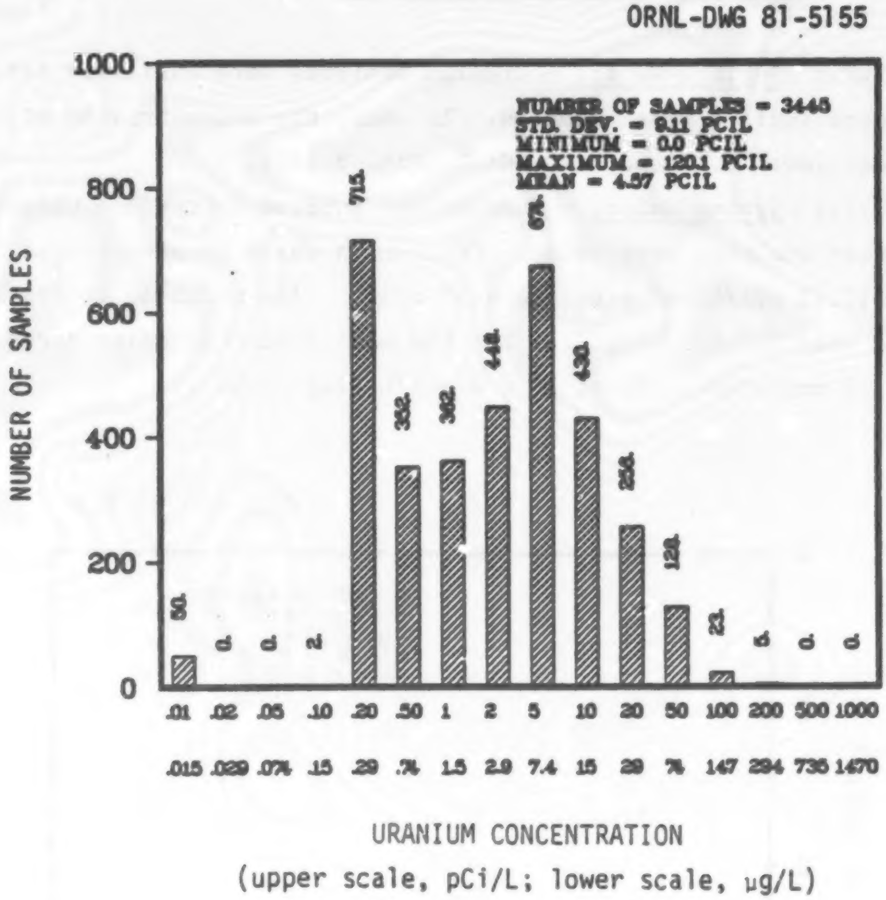


Fig. 3.137. Histogram of uranium concentrations in ground waters of Oklahoma.

3.37.2.3 Established Domestic and Municipal Waters — Of the listed Oklahoma sites 2818 were identified as sources of domestic or municipal water. Concentrations of uranium in water from these sources varied from 0.01 to 120.15 pCi/L and averaged 3.89 pCi/L. The modal and median concentration ranges were 0.1 to 0.2 pCi/L and 1 to 2 pCi/L, respectively (Fig. 3.138).

3.37.2.4 Treated Waters from Municipal Water Purification Plants — Processed water from the Lake Hefner treatment plant in Oklahoma City and the Spavinaw Creek Plant in Tulsa contained 0.20 and 0.14 pCi/L uranium, respectively, in 1961. A more recent sample of water from Oklahoma City, composited between July and December, 1977, contained

ORNL-DWG 81-5156

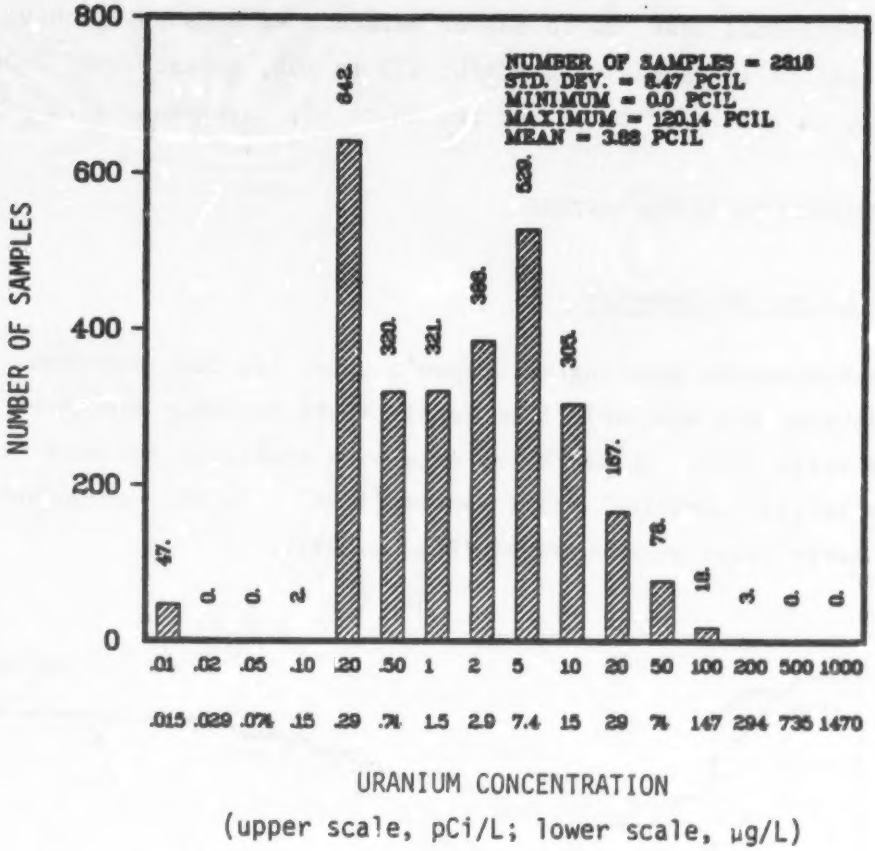


Fig. 3.138. Histogram of uranium concentrations in domestic waters of Oklahoma.

0.092, 0.003, and 0.075 pCi/L of $^{234}$U, $^{235}$U, and $^{238}$U, respectively [1]. The total uranium activity of this sample was 0.170 pCi/L, in good agreement with the 1961 analysis.

### 3.37.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Oklahoma domestic water was estimated as 2.5 pCi/L, 6th highest among all states (Appendix 2). The alpha radiation bone dose based on this average was 38 mrem/year for Model I and 1 mrem/year for Model II.

### 3.37.4 Water Supplies Exceeding Given Concentrations

We estimated that 50% to 53% of Oklahoma water supplies have uranium concentrations in excess of 1 pCi/L; 17% to 20%, in excess of 5 pCi/L; 0% to 9%, in excess of 10 pCi/L; and 0% to 4%, in excess of 20 pCi/L.

## 3.38 URANIUM IN OREGON WATERS

### 3.38.1 Extent of Coverage

No systematic sampling of Oregon's water has been reported, but a few analyses were available from county seats randomly scattered throughout the state [15]. In addition, data were available for water from the state's largest municipal water system [1,26]. In all, seven surface and ground water sites were surveyed (Fig. 3.139).

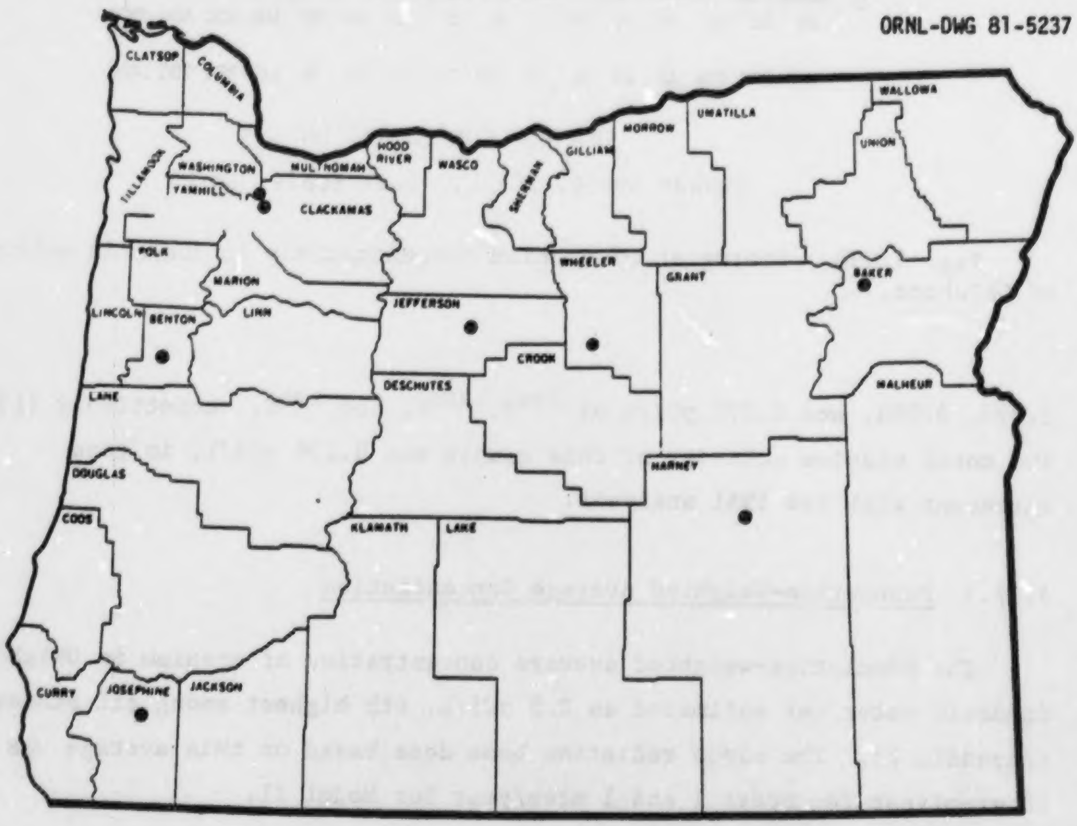

ORNL-DWG 81-5237
CLATSOP
COLUMBIA
TILLAMOOK
WASHINGTON
MULTNOMAH
YAMHILL
HOOD RIVER
WASCO
SHERMAN
GILLIAM
MORROW
UMATILLA
WALLOWA
UNION
CLACKAMAS
POLK
MARION
LINCOLN
BENTON
LINN
JEFFERSON
WHEELER
GRANT
BAKER
CROOK
LANE
DESCHUTES
MALHEUR
HARNEY
DOUGLAS
COOS
KLAMATH
LAKE
CURRY
JOSEPHINE
JACKSON

Fig. 3.139. Locations of sample sites in Oregon.

### 3.38.2 Concentrations of Uranium in Samples

3.38.2.1 Surface Waters — Data were available for only one Oregon surface water site. The concentration of uranium in this sample was 0.14 pCi/L (Fig. 3.140).

3.38.2.2 Ground Waters — Six Oregon ground water sites were sampled. Uranium in these waters ranged from 0.07 to 0.48 pCi/L and averaged 0.22 pCi/L. Two concentration ranges were equally represented: 0.05 to 0.1 pCi/L and 0.2 to 0.5 pCi/L (Fig. 3.141).

3.38.2.3 Established Domestic and Municipal Waters — Six of the Oregon sample sites were identified as domestic water sources. Uranium

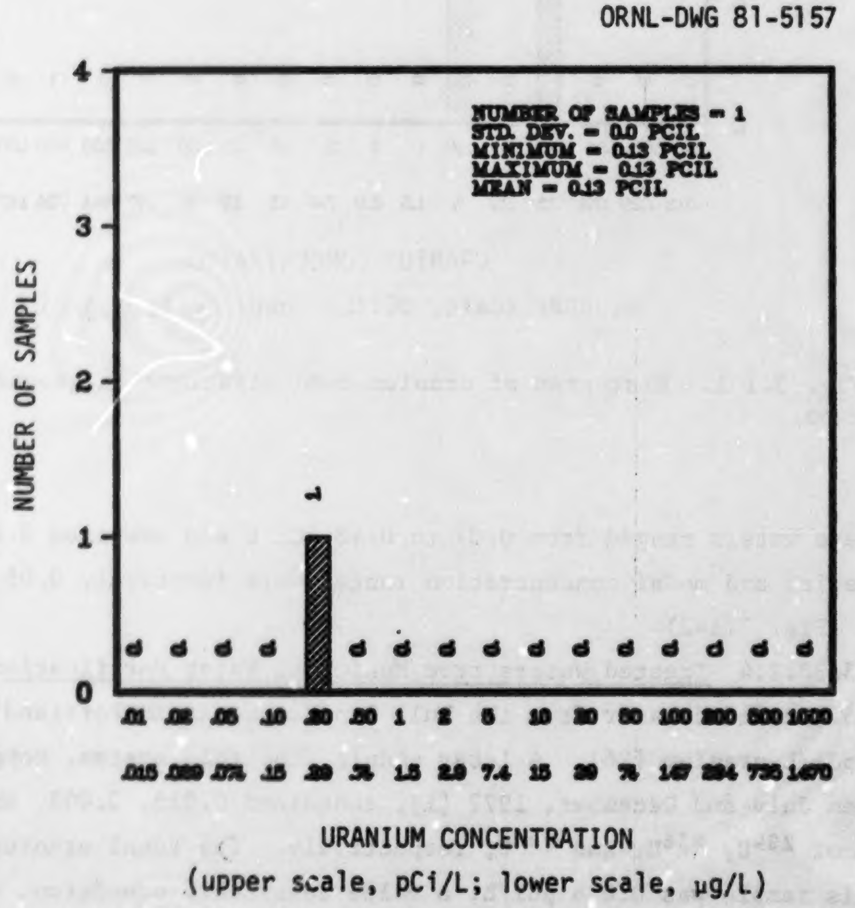


Fig. 3.140. Histogram of uranium concentrations in surface waters of Oregon.

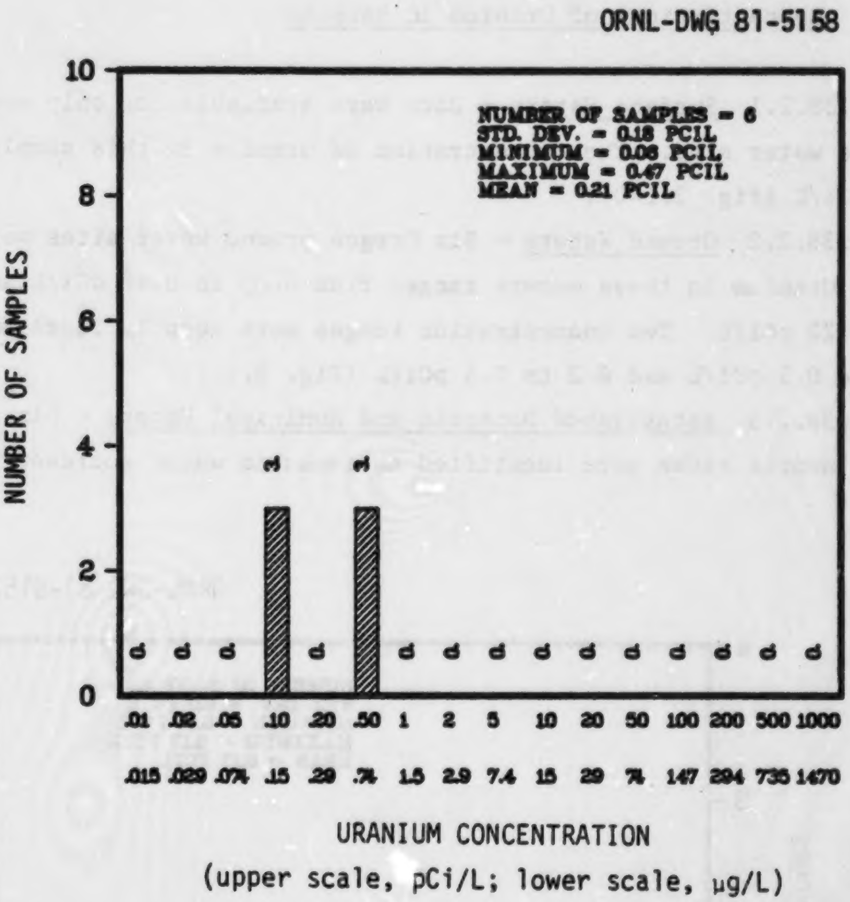


Fig. 3.141. Histogram of uranium concentrations in ground waters of Oregon.

in these waters ranged from 0.07 to 0.48 pCi/L and averaged 0.17 pCi/L. The median and modal concentration ranges were identical, 0.05 to 0.1 pCi/L (Fig. 3.142).

3.38.2.4 Treated Waters from Municipal Water Purification Plants — In 1962, treated water from the Bull Run Headworks in Portland contained 0.14 pCi/L uranium [26]. A later sample from this system, composited between July and December, 1977 [1], contained 0.015, 0.002, and 0.011 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total uranium activity of this sample was 0.028 pCi/L, a value reasonably consistent with the 1962 analysis.

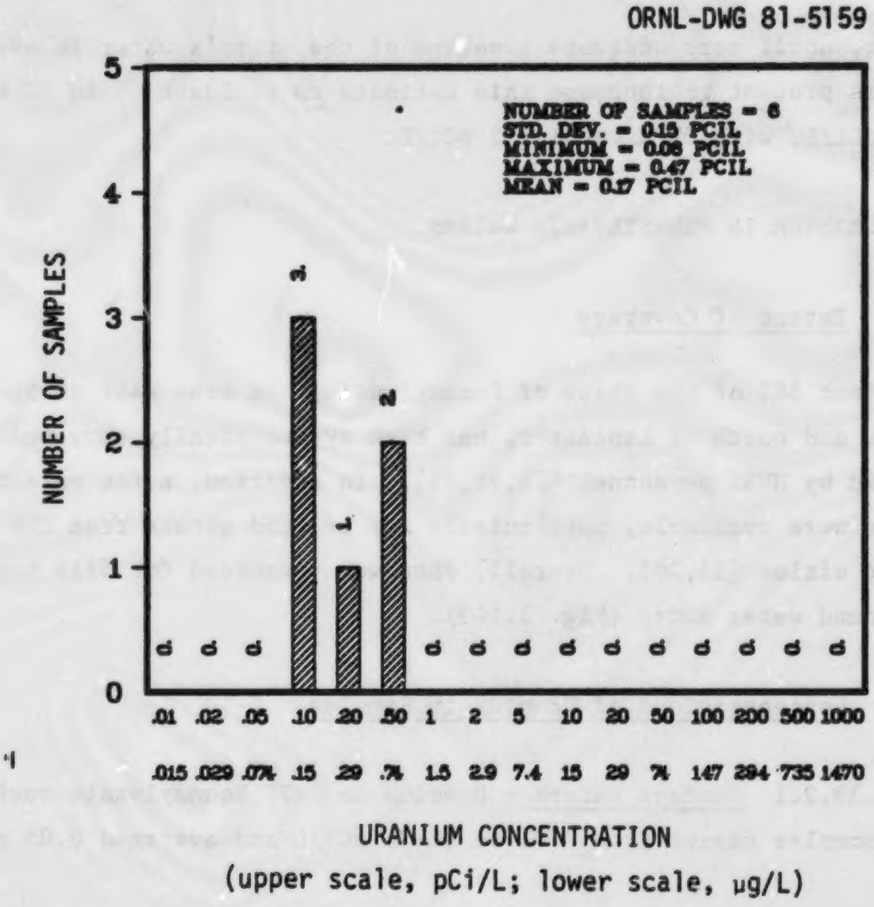


Fig. 3.142. Histogram of uranium concentrations in domestic waters of Oregon.

### 3.38.3 Population-Weighted Average Concentration

On the basis of very limited data, the population-weighted average concentration of uranium in Oregon domestic waters was estimated to be <0.1 pCi/L, 17th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.38.4 Water Supplies Exceeding Given Concentrations

Based on the limited data presented here we estimated that no Oregon water supply has uranium concentrations in excess of 1 pCi/L.

However, until more adequate coverage of the state's water is available it seems prudent to increase this estimate to at least 0% to 5% exceeding 1 pCi/L, with 0% exceeding 5 pCi/L.

## 3.39 URANIUM IN PENNSYLVANIA WATERS

### 3.39.1 Extent of Coverage

About 58% of the state of Pennsylvania, the area east of State College and north of Lancaster, has been systematically surveyed and reported by NURE personnel [71,74,75]. In addition, a few selected samples were available, particularly for treated waters from the four largest cities [15,26]. Overall, data were recorded for 5716 surface and ground water sites (Fig. 3.143).

### 3.39.2 Concentrations of Uranium in Samples

3.39.2.1 Surface Waters — Uranium in 2477 Pennsylvania surface water samples ranged from 0.01 to 12.36 pCi/L and averaged 0.05 pCi/L.

ORNL-DWG 81-5238

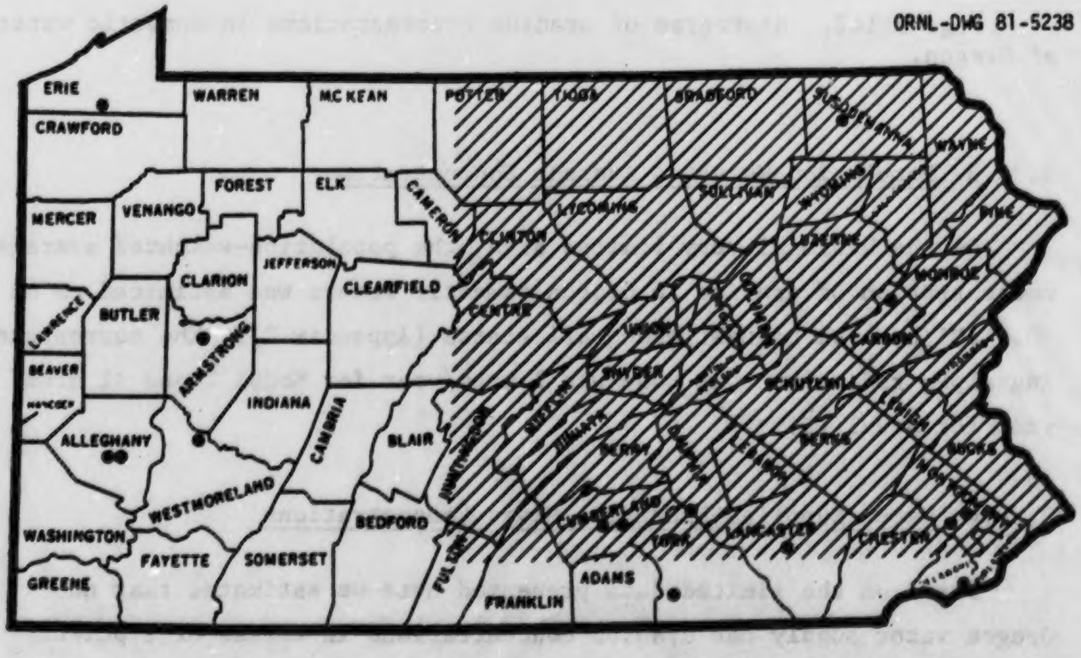

ERIE
CRAWFORD
WARREN
MC KEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
MERCER
VENANGO
FOREST
ELK
CAMERON
LYCOMING
SULLIVAN
WYOMING
PIKE
CLINTON
LUZERNE
JEFFERSON
CLARION
CLEARFIELD
MONROE
LAWRENCE
BUTLER
ARMSTRONG
CENTRE
UNION
COLUMBIA
CARBON
BEAVER
SNYDER
SCHUYLKILL
INDIANA
CAMBRIA
MIFFLIN
LEHIGH
ALLEGHANY
BLAIR
HUNTINGDON
JUNIATA
PERRY
DAUPHIN
LEBANON
BERKS
BUCKS
WESTMORELAND
CUMBERLAND
YORK
LANCASTER
CHESTER
WASHINGTON
FAYETTE
SOMERSET
BEDFORD
FULTON
GREENE
ADAMS
FRANKLIN

Fig. 3.143. Locations of sample sites in Pennsylvania.

The median and modal concentrations were identical, 0.01 pCi/L (Fig. 3.144).

3.39.2.2 Ground Waters — The concentrations of uranium in 3239 ground water samples varied from 0.01 to 15.23 pCi/L and averaged 0.19 pCi/L. The mode for this subset was 0.01, but the median concentration range was slightly higher: 0.02 to 0.05 pCi/L (Fig. 3.145).

3.39.2.3 Established Domestic and Municipal Waters — Of the listed Pennsylvania sites 2772 were identified as sources of domestic or municipal water. The concentrations of uranium in these samples varied from 0.01 to 15.23 pCi/L and averaged 0.22 pCi/L. The modal concentration was 0.01 pCi/L, and the median concentration range was 0.02 to 0.05 pCi/L (Fig. 3.146).

ORNL-DWG 81-5160

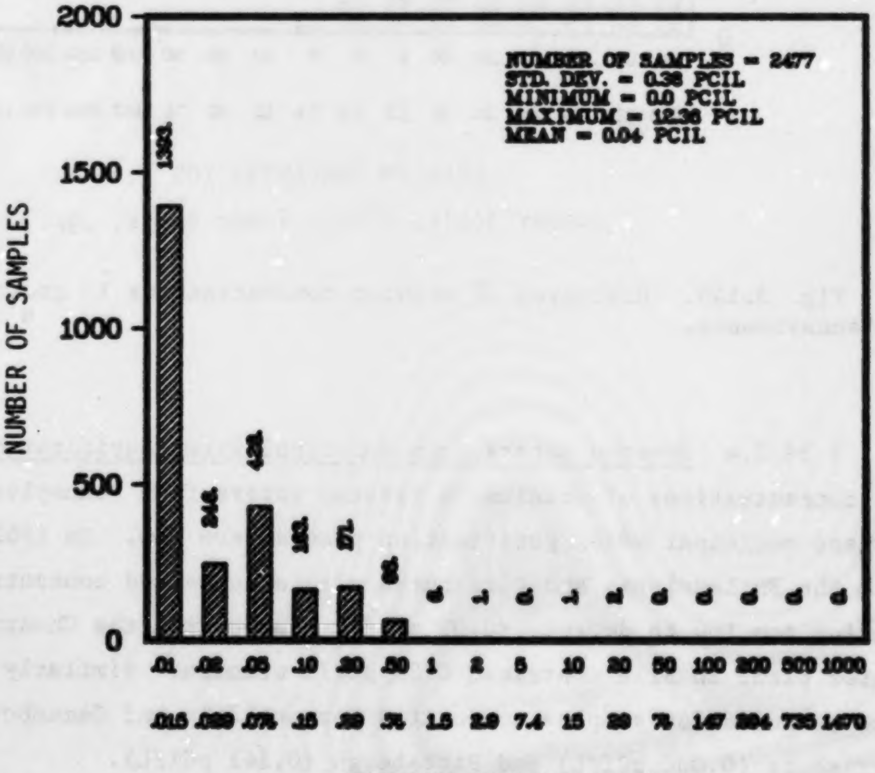


Fig. 3.144. Histogram of uranium concentrations in surface waters of Pennsylvania.

ORNL-DWG 81-5161

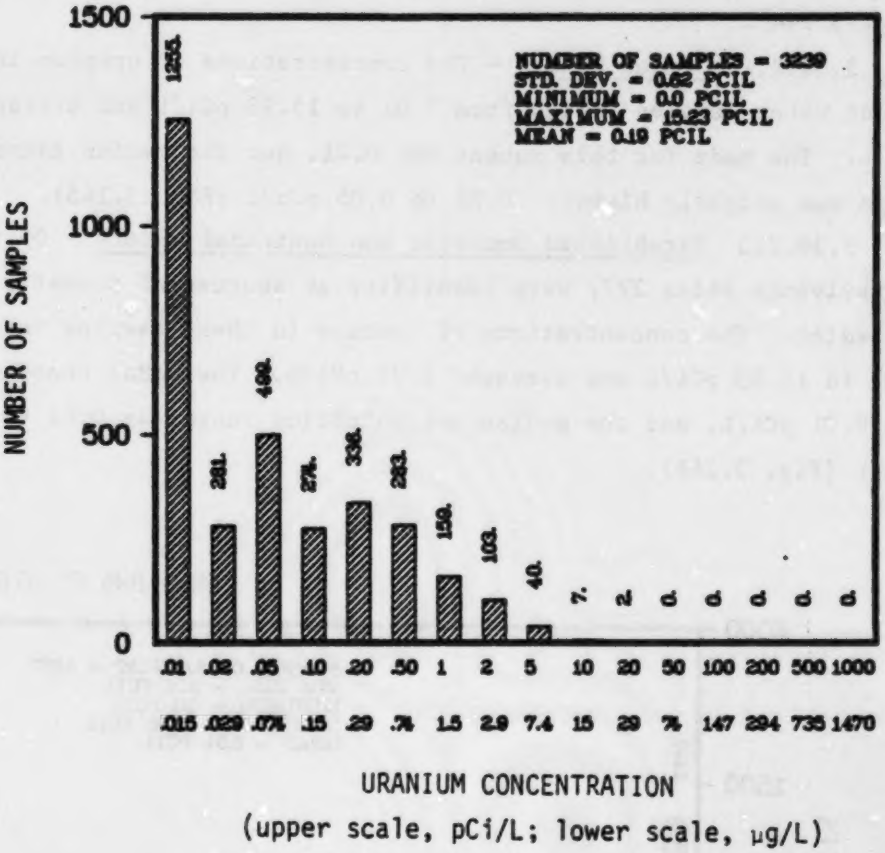


**Fig. 3.145. Histogram of uranium concentrations in ground waters of Pennsylvania.**

**3.39.2.4 Treated Waters from Municipal Water Purification Plants — The concentrations of uranium in treated waters from Pennsylvania's four largest municipal water purification plants were low. In 1962, samples from the Philadelphia and Pittsburgh plants contained concentrations of uranium too low to detect, <0.07 pCi/L. Water from the Chestnut Street filter plant in Erie contained 0.20 pCi/L uranium. Similarly low values were measured for samples composited between July and December, 1977, in Harrisburg (0.030 pCi/L) and Pittsburgh (0.141 pCi/L).**

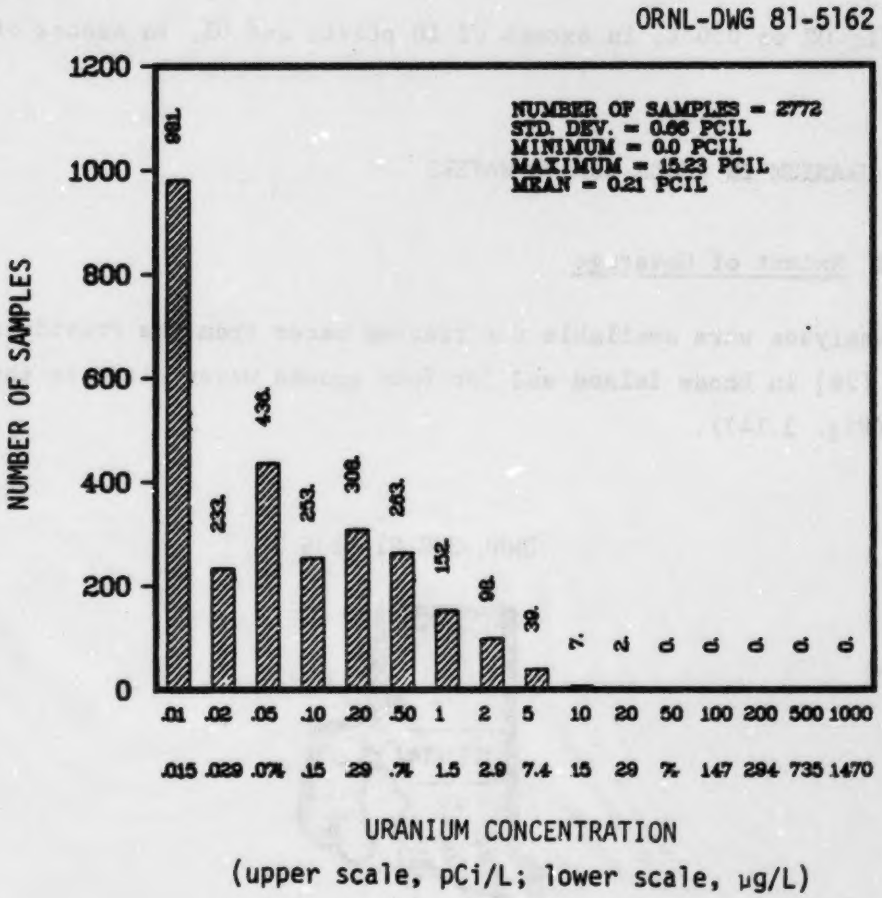


**Fig. 3.146. Histogram of uranium concentrations in domestic waters of Pennsylvania.**

### 3.39.3 Population-Weighted Average Concentration

**The population-weighted average concentration of uranium in Pennsylvania domestic waters was estimated to be <0.1 pCi/L, 17th highest among all states (Appendix 2). The alpha radiation bone dose resulting from this average was estimated to be 1 mrem/year for Model I and <1 mrem/year for Model II.**

### 3.39.4 Water Supplies Exceeding Given Concentrations

**We estimated that 2% to 5% of Pennsylvania water supplies have uranium concentrations in excess of 1 pCi/L; 0% to 0.3%, in excess of**

5 pCi/L; 0% to 0.07%, in excess of 10 pCi/L; and 0%, in excess of 20 pCi/L.

## 3.40 URANIUM IN RHODE ISLAND WATERS

### 3.40.1 Extent of Coverage

Analyses were available for treated water from the Providence filter plant [26] in Rhode Island and for four ground water sites in the state [15] (Fig. 3.147).

ORNL-DWG 81-5239

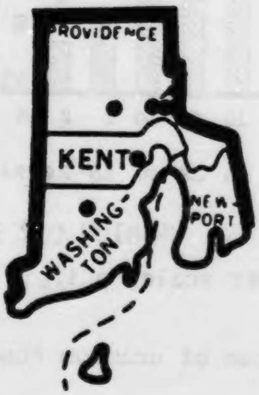


Fig. 3.147. Locations of sample sites in Rhode Island.

### 3.40.2 Concentrations of Uranium in Samples

3.40.2.1 Surface Waters — The sole Rhode Island surface water sample was from the North Branch Pawtuxet River and was analyzed after treatment in the Providence municipal water treatment plant; it contained less than 0.07 pCi/L uranium (Fig. 3.148).

3.40.2.2 Ground Waters — The concentrations of uranium in the four listed Rhode Island ground water samples were also low, ranging from 0.07 pCi/L to 0.95 pCi/L and averaging 0.43 pCi/L. Two concentration ranges were equally represented: 0.05 to 0.1 pCi/L and 0.5 to 1 pCi/L (Fig. 3.149).

ORNL-DWG 81-5163

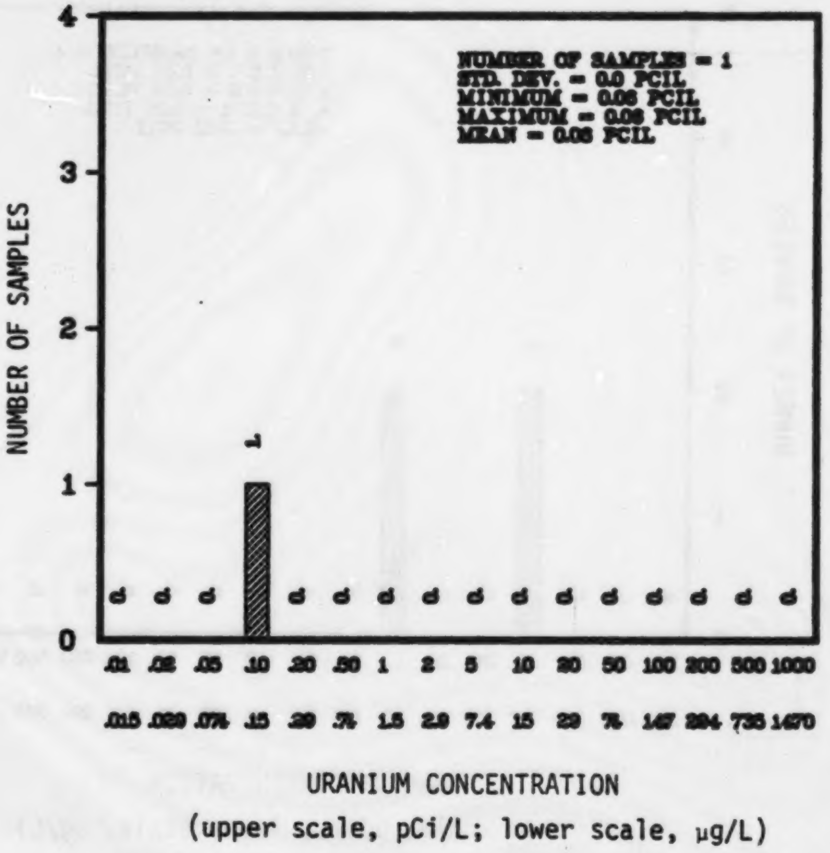


Fig. 3.148. Histogram of uranium concentrations in surface waters of Rhode Island.

3.40.2.3 Established Domestic and Municipal Waters — Four of the five listed sites were identified as domestic or municipal water sources. The uranium contents of waters from these sources ranged from 0.07 pCi/L to 0.95 pCi/L and averaged 0.29 pCi/L. The modal and median concentration ranges for this subset were identical, 0.05 to 0.1 pCi/L (Fig. 3.150).

3.40.2.4 Treated Waters from Municipal Water Purification Plants — The concentration of uranium in treated water from the Providence filter plant was below the level of detection (<0.07 pCi/L) in 1962.

ORNL-DWG 81-5164

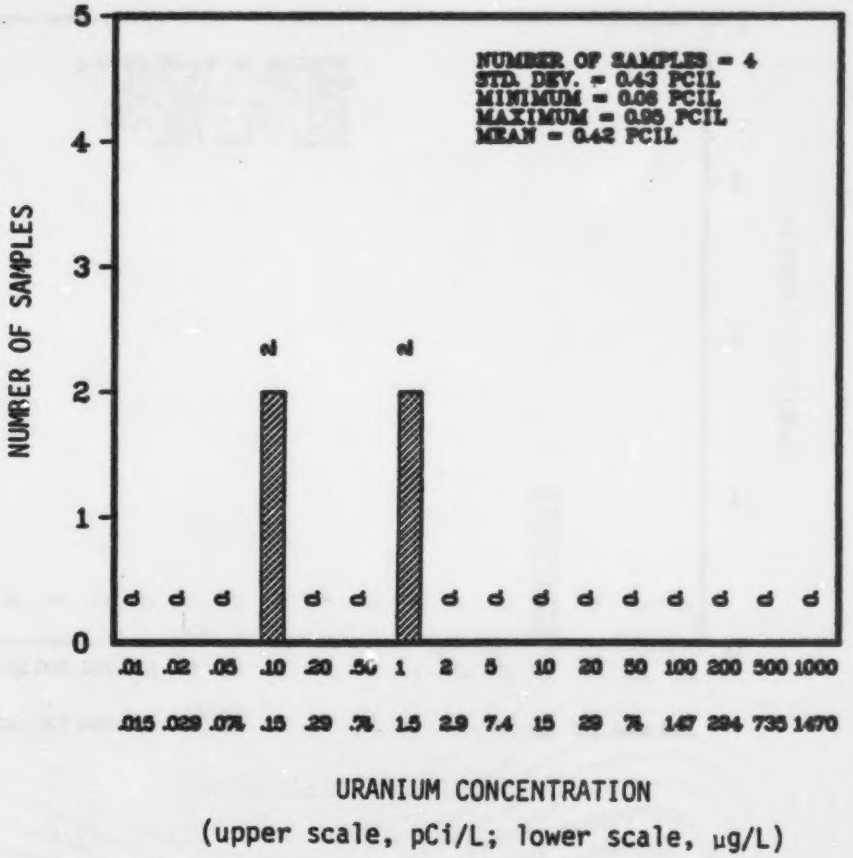


Fig. 3.149. Histogram of uranium concentrations in ground waters of Rhode Island.

### 3.40.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Rhode Island domestic water was estimated to be 0.1 pCi/L, 16th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 2 mrem/year for Model I and <1 mrem/year for Model II.

### 3.40.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% of Rhode Island water supplies contain uranium in excess of 1 pCi/L.

ORNL-DWG 81-5165

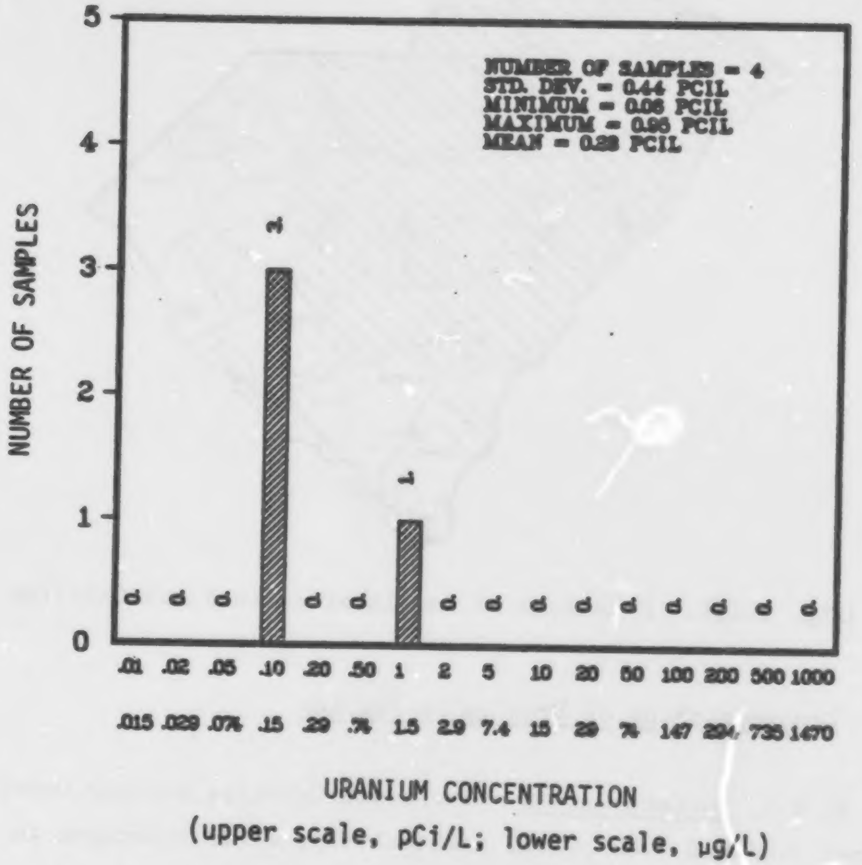


Fig. 3.150. Histogram of uranium concentrations in domestic waters of Rhode Island.

## 3.41 URANIUM IN SOUTH CAROLINA WATERS

### 3.41.1 Extent of Coverage

NURE analyses were available for about 70% of South Carolina waters, mainly the western, northwestern, and central sectors [69,70,73,77,78,85]. Data were also found for a few sites not reported by NURE investigators, including treated waters from the Barnwell and Columbia water treatment facilities [26]. Altogether, 2450 water sites were surveyed (Fig. 3.151).

ORNL-DWG 81-5240

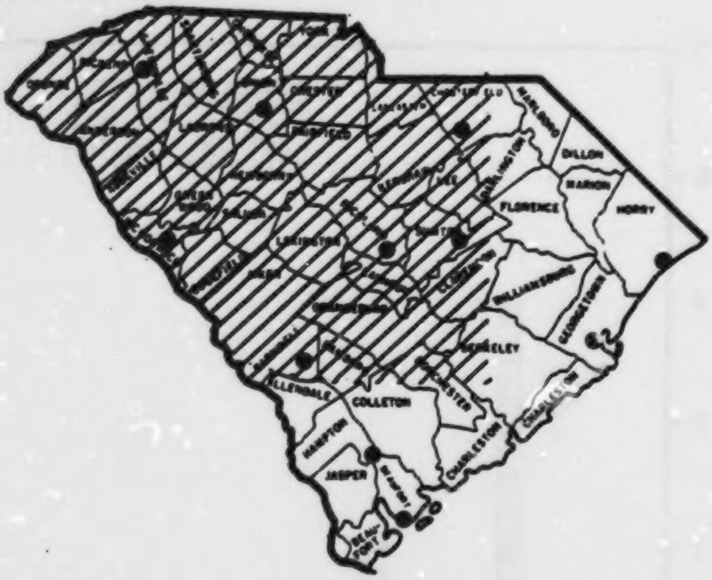

YORK
CHESTER
FAIRFIELD
CHESTERFIELD
MARLBORO
DILLON
DARLINGTON
MARION
HORRY
FLORENCE
LEE
SUMTER
LEXINGTON
NEWBERRY
AIKEN
WILLIAMSBURG
CLARENDON
GEORGETOWN
ORANGEBURG
BERKELEY
BARNWELL
ALLENDALE
COLLETON
DORCHESTER
CHARLESTON
HAMPTON
JASPER
BEAUFORT

Fig. 3.151. Locations of sample sites in South Carolina.

### 3.41.2 Concentrations of Uranium in Samples

3.41.2.1 Surface Waters — Two South Carolina surface water samples contained 0.05 and 0.03 pCi/L, respectively, after treatment in the Barnwell and Columbia water treatment facilities (Fig. 3.152).

3.41.2.2 Ground Waters — Concentrations of uranium in 2448 South Carolina ground water samples ranged from 0.01 to 56.57 pCi/L and averaged 0.15 pCi/L. The median and modal concentration ranges for these samples were the same, 0.02 to 0.05 pCi/L (Fig. 3.153).

3.41.2.3 Established Domestic and Municipal Waters — Of the South Carolina sites 2361 were identified as domestic or municipal water sources. Uranium in these samples ranged from 0.01 to 56.57 pCi/L and averaged 0.15 pCi/L. The median and modal concentration ranges for these samples were identical, 0.02 to 0.05 pCi/L (Fig. 3.154).

3.41.2.4 Treated Waters from Municipal Water Purification Plants — Water samples from the Barnwell and Columbia water systems were separately composited between July and December, 1977, by EPA Office of Radiation Programs personnel [1]. The Barnwell sample contained 0.025, 0.002, and 0.020 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively. The total concentration of uranium in this sample was 0.047 pCi/L. The Columbia sample

ORNL-DWG 81-5166

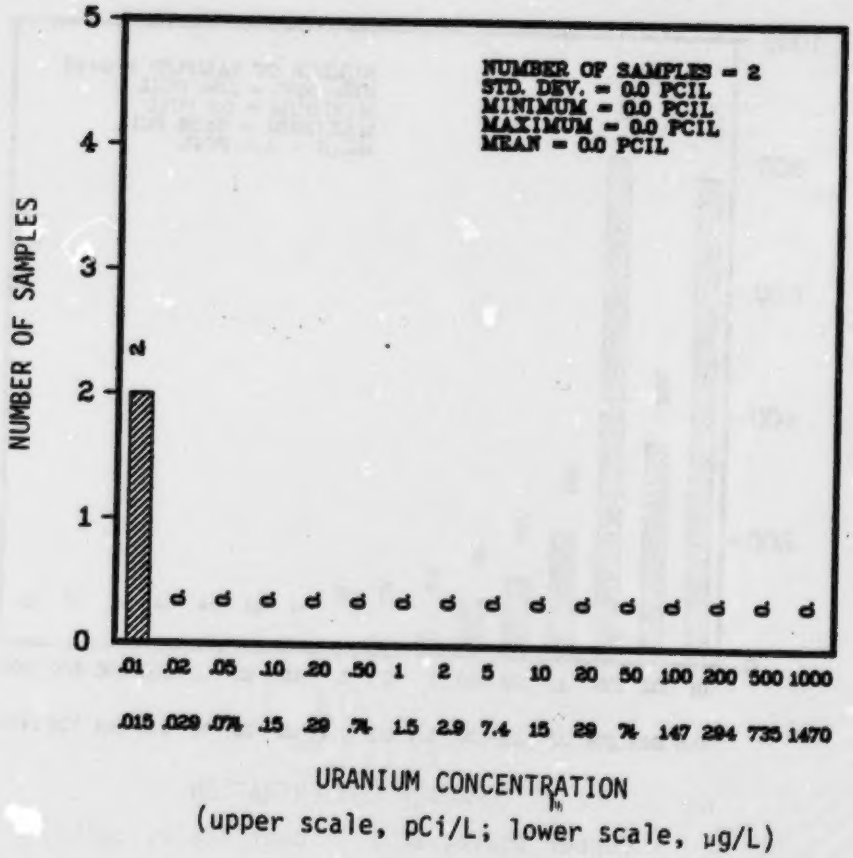


Fig. 3.152. Histogram of uranium concentrations in surface waters of South Carolina.

contained 0.017, 0.001, and 0.009 pCi/L of $^{234}$U, $^{235}$U, and $^{238}$U, respectively. The total uranium concentration was 0.027 pCi/L.

### 3.41.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in South Carolina domestic water was estimated to be 0.2 pCi/L, 15th highest among all states (Appendix 2). The alpha radiation bone dose associated with this concentration of uranium in drinking water was 3 mrem/year for Model I and <1 mrem/year for Model II.

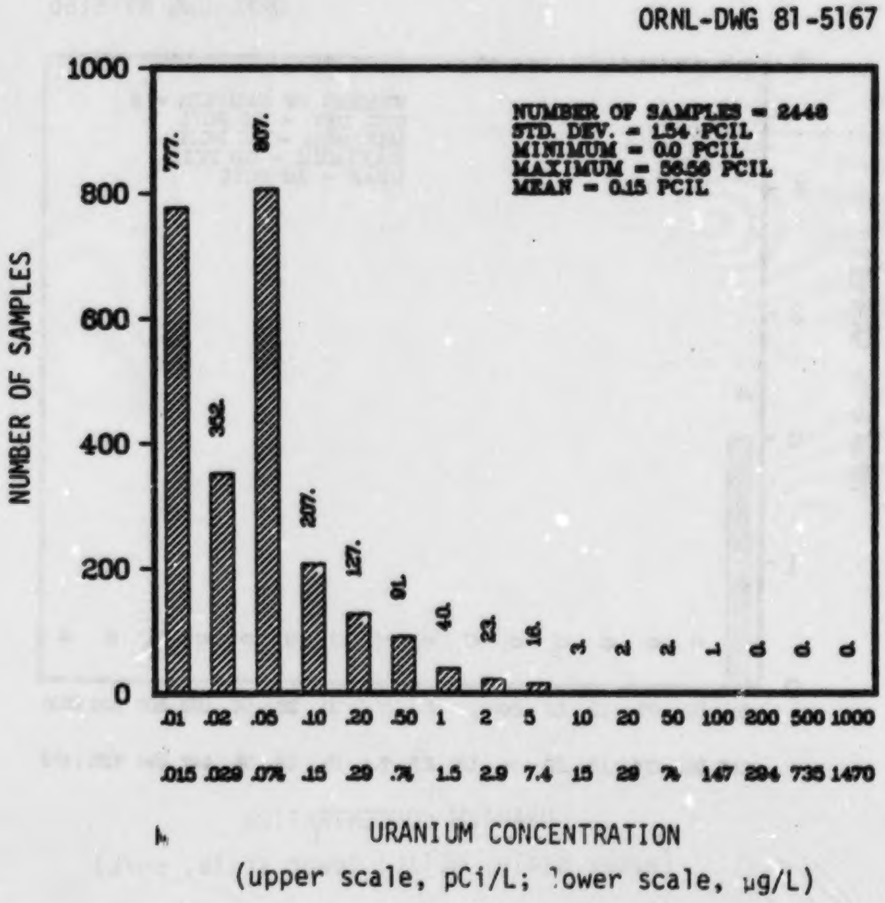


Fig. 3.153. Histogram of uranium concentrations in ground waters of South Carolina.

### 3.41.4 Water Supplies Exceeding Given Concentrations

We estimated that 2% to 54% of South Carolina water supplies have uranium in excess of 1 pCi/L; 0% to 0.3%, in excess of 5 pCi/L; 0% to 0.2%, in excess of 10 pCi/L; and 0% to 0.1% in excess of 20 pCi/L.

## 3.42 URANIUM IN SOUTH DAKOTA WATERS

### 3.42.1 Extent of Coverage

NURE data have been reported for approximately 17% of South Dakota, specifically the extreme northwest and southwest sectors [105,121].

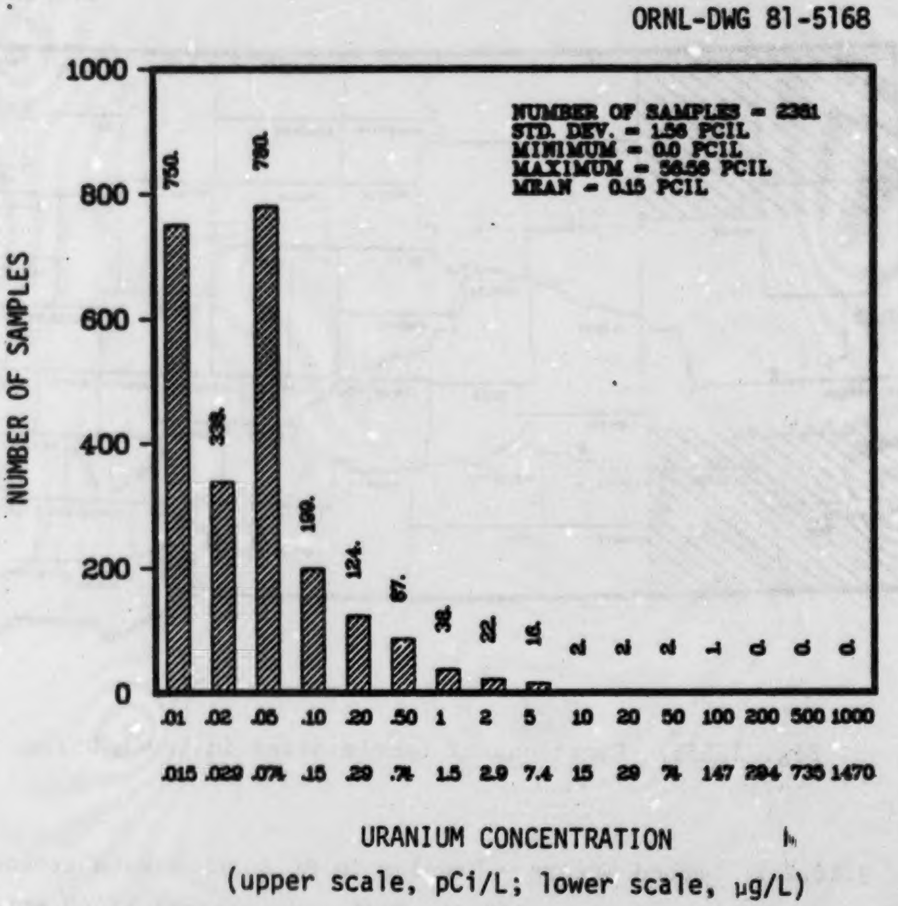


Fig. 3.154. Histogram of uranium concentrations in domestic waters of South Carolina.

Analyses of a few additional samples were also found [15], mostly for the southwest section already covered by NURE data. Overall, 350 surface and ground water sites were surveyed (Fig. 3.155).

### 3.42.2 Concentrations of Uranium in Samples

3.42.2.1 Surface Waters — The concentrations of uranium in 264 South Dakota surface water samples ranged from 0.01 to 4.22 pCi/L and averaged 0.26 pCi/L. The median and modal concentration ranges for this subset were identical, 0.1 to 0.2 pCi/L (Fig. 3.156).

ORNL-DWG 81-5241

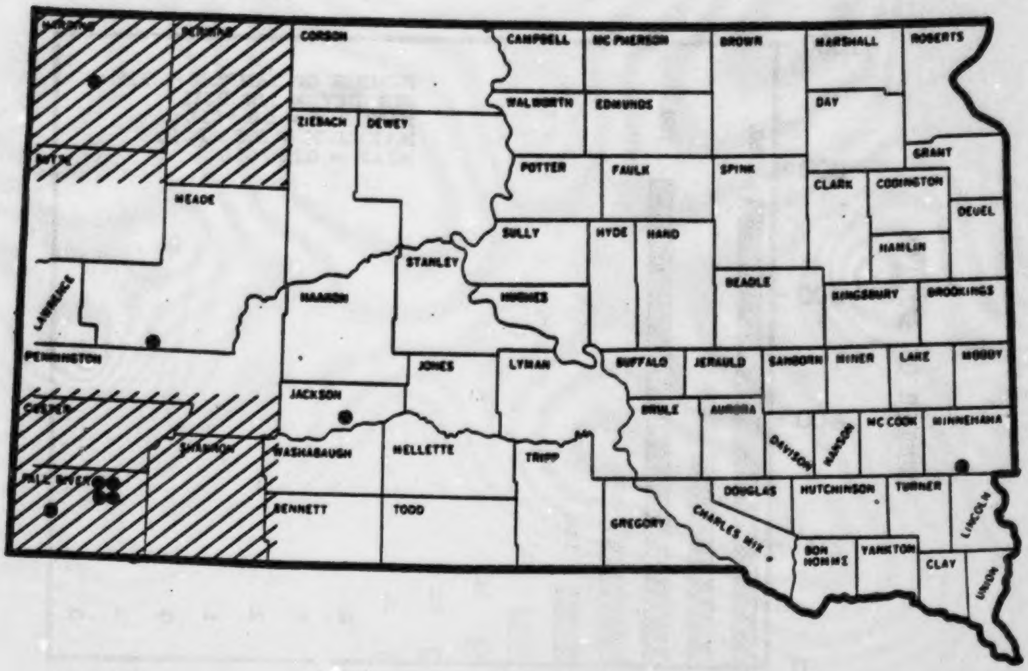

HARDING
PERKINS
CORSON
CAMPBELL
MC PHERSON
BROWN
MARSHALL
ROBERTS
WALWORTH
EDMUNDS
DAY
ZIEBACH
DEWEY
BUTTE
GRANT
POTTER
FAULK
SPINK
CLARK
CODINGTON
MEADE
DEUEL
SULLY
HYDE
HAND
HAMLIN
STANLEY
LAWRENCE
HAAKON
HUGHES
BEADLE
KINGSBURY
BROOKINGS
PENNINGTON
JONES
LYMAN
BUFFALO
JERAULD
SANBORN
MINER
LAKE
MOODY
JACKSON
CUSTER
BRULE
AURORA
DAVISON
HANSON
MC COOK
MINNEHAHA
SHANNON
WASHABAUGH
MELLETTE
TRIPP
FALL RIVER
DOUGLAS
HUTCHINSON
TURNER
BENNETT
TODD
GREGORY
CHARLES MIX
LINCOLN
BON HOMME
YANKTON
CLAY
UNION

Fig. 3.155. Locations of sample sites in South Dakota.

3.42.2.2 Ground Waters — Uranium in 86 South Dakota ground water samples ranged from 0.07 to 129.54 pCi/L and averaged 11.69 pCi/L. The median and modal concentration ranges were 2 to 5 pCi/L and 5 to 10 pCi/L, respectively (Fig. 3.157).

3.42.2.3 Established Domestic and Municipal Waters — Fifty-one of the listed South Dakota sites were identified as domestic or municipal sources. The concentrations of uranium in these waters ranged from 0.07 to 129.54 pCi/L and averaged 12.39 pCi/L. The median and modal concentration ranges for these samples were identical, 5 to 10 pCi/L (Fig. 3.158).

3.42.2.4 Treated Waters from Municipal Water Purification Plants — None of the listed samples was definitely identified as water treated by standard municipal water purification processes.

ORNL-DWG 81-5169

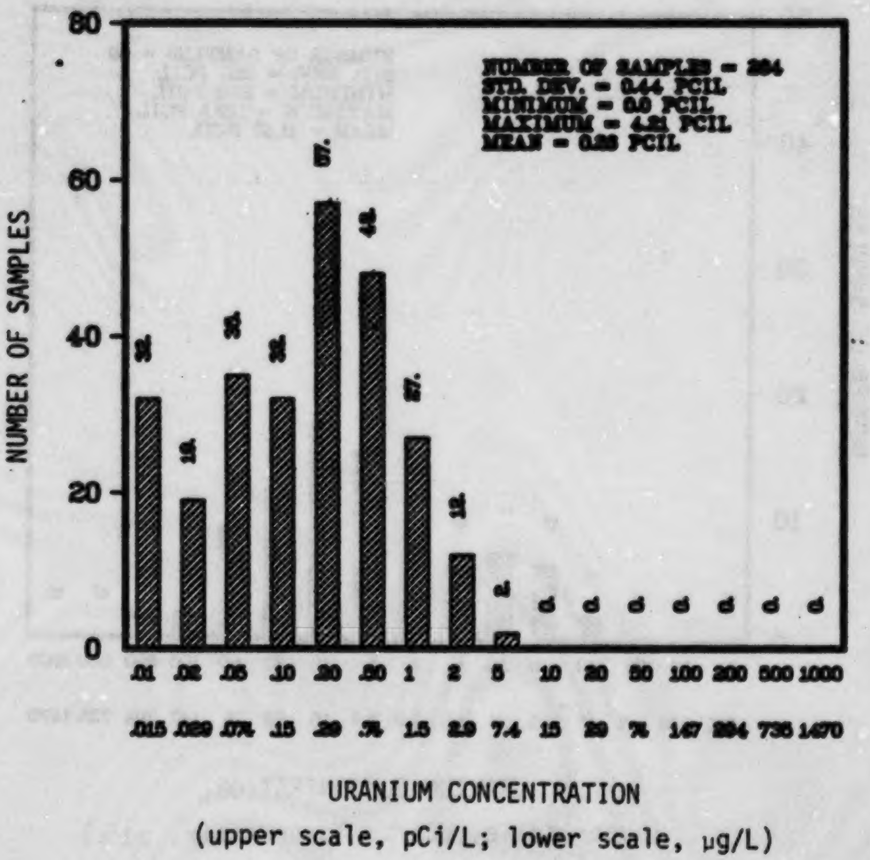


Fig. 3.156. Histogram of uranium concentrations in surface waters of South Dakota.

### 3.42.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in South Dakota domestic waters was estimated to be 6.7 pCi/L, the highest of all states (Appendix 2). The alpha radiation bone dose computed with this average value was 101 mrem/year for Model I and 4 mrem/year for Model II.

### 3.42.4 Water Supplies Exceeding Given Concentrations

We estimated that 78% to 83% of South Dakota water supplies have uranium concentrations exceeding 1 pCi/L; 55% to 83%, exceeding 5 pCi/L; 0% to 31%, exceeding 10 pCi/L; and 0% to 12%, exceeding 20 pCi/L.

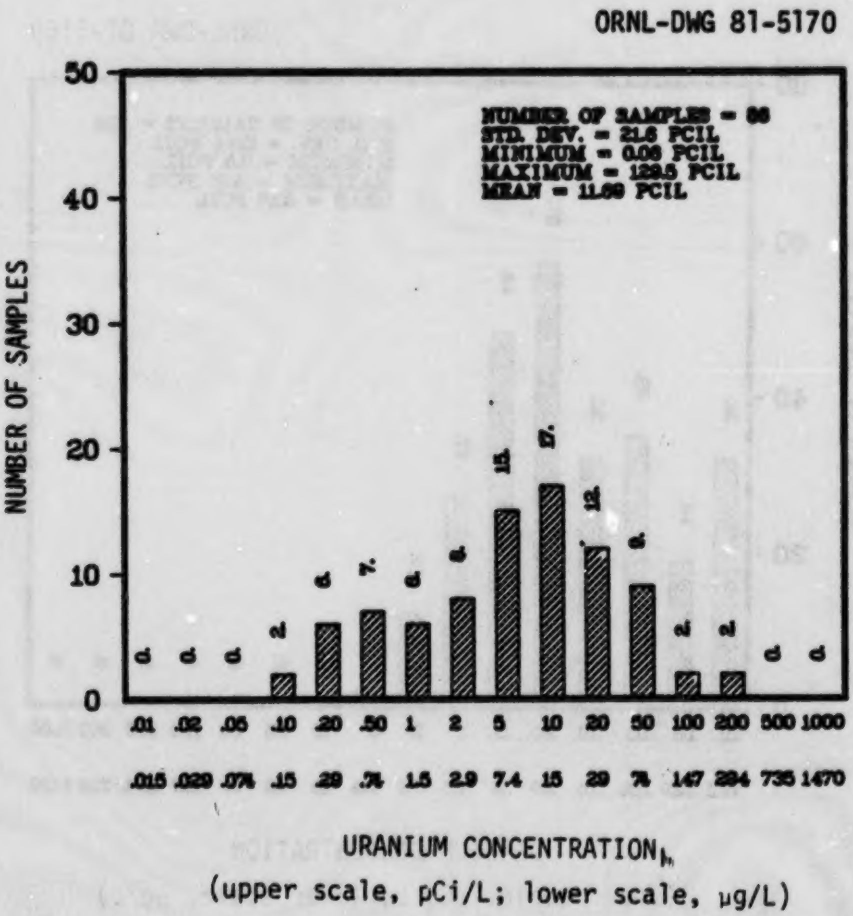


Fig. 3.157. Histogram of uranium concentrations in ground waters of South Dakota.

## 3.43 URANIUM IN TENNESSEE WATERS

### 3.43.1 Extent of Coverage

NURE analyses were available for about 14% of the state, chiefly the extreme northwestern, northeastern, and southeastern sectors [67, 73,83]. Data were also found for water from an additional seven widely dispersed towns [15] and for the municipal water treatment plants [1,26] in the state's four largest cities (Fig. 3.159). Overall, 915 surface and ground water sites were surveyed.

ORNL-DWG 81-5171

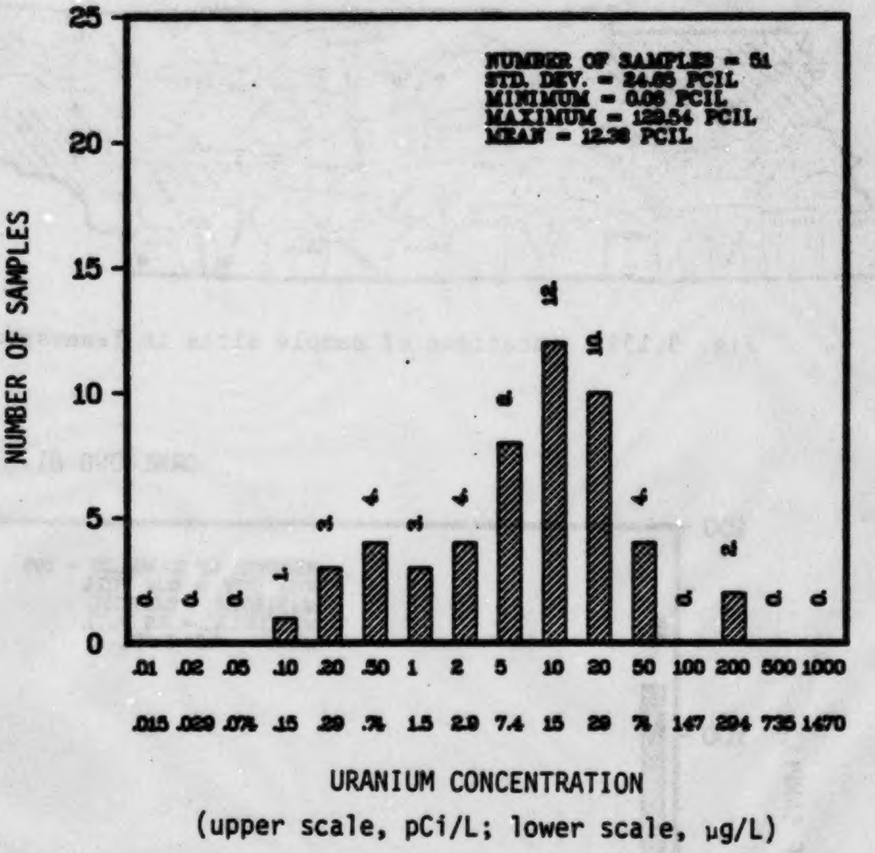


Fig. 3.158. Histogram of uranium concentrations in domestic waters of South Dakota.

### 3.43.2 Concentrations of Uranium in Samples

3.43.2.1 Surface Waters — Concentrations of uranium in 168 Tennessee surface waters ranged from 0.01 to 0.92 pCi/L and averaged 0.09 pCi/L. The median and modal concentrations for this subset were identical, 0.01 pCi/L (Fig. 3.160).

3.43.2.2 Ground Waters — Uranium in 747 Tennessee ground water samples varied from 0.01 to 13.08 pCi/L and averaged 0.15 pCi/L. As was the case with Tennessee surface waters, the median and modal concentrations for this subset were also low and identical, 0.01 pCi/L (Fig. 3.161).

ORNL-DWG 81-5242

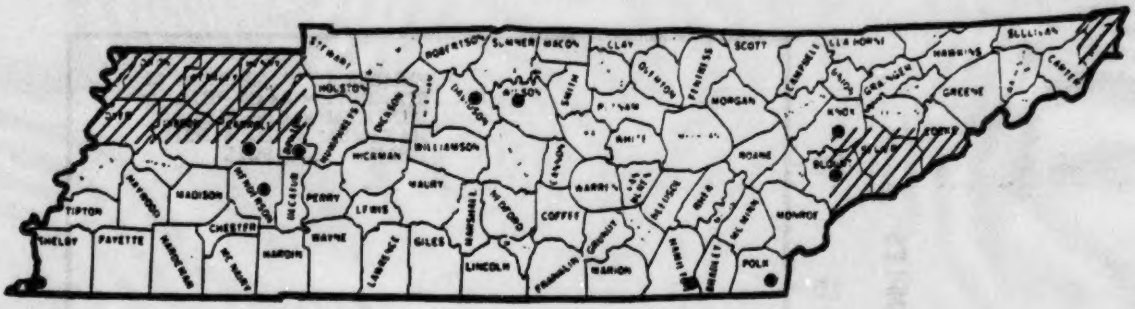

STEWART
ROBERTSON
SUMNER
MACON
CLAY
SCOTT
CLAIBORNE
SULLIVAN
HAWKINS
CARTER
GREENE
HOUSTON
DICKSON
DAVIDSON
WILSON
SMITH
FENTRESS
MORGAN
CAMPBELL
GRAINGER
KNOX
SEVIER
COCKE
BLOUNT
PUTNAM
WHITE
ROANE
WILLIAMSON
HICKMAN
MAURY
CANNON
WARREN
MONROE
POLK
MARION
FRANKLIN
LINCOLN
COFFEE
GILES
LAWRENCE
WAYNE
LEWIS
PERRY
DECATUR
HARDIN
MC NAIRY
CHESTER
MADISON
HAYWOOD
HARDEMAN
FAYETTE
SHELBY
TIPTON
MARSHALL
BEDFORD
HUMPHREYS

Fig. 3.159. Locations of sample sites in Tennessee.

ORNL-DWG 81-5172

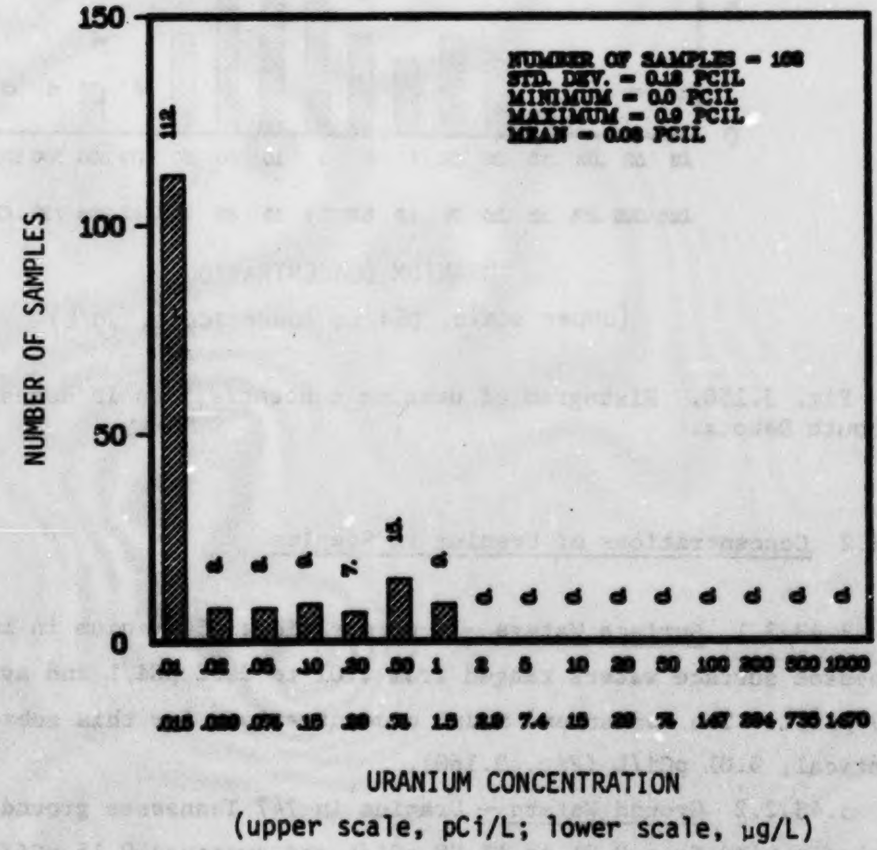


Fig. 3.160. Histogram of uranium concentrations in surface waters of Tennessee.

ORNL-DWG 81-5173

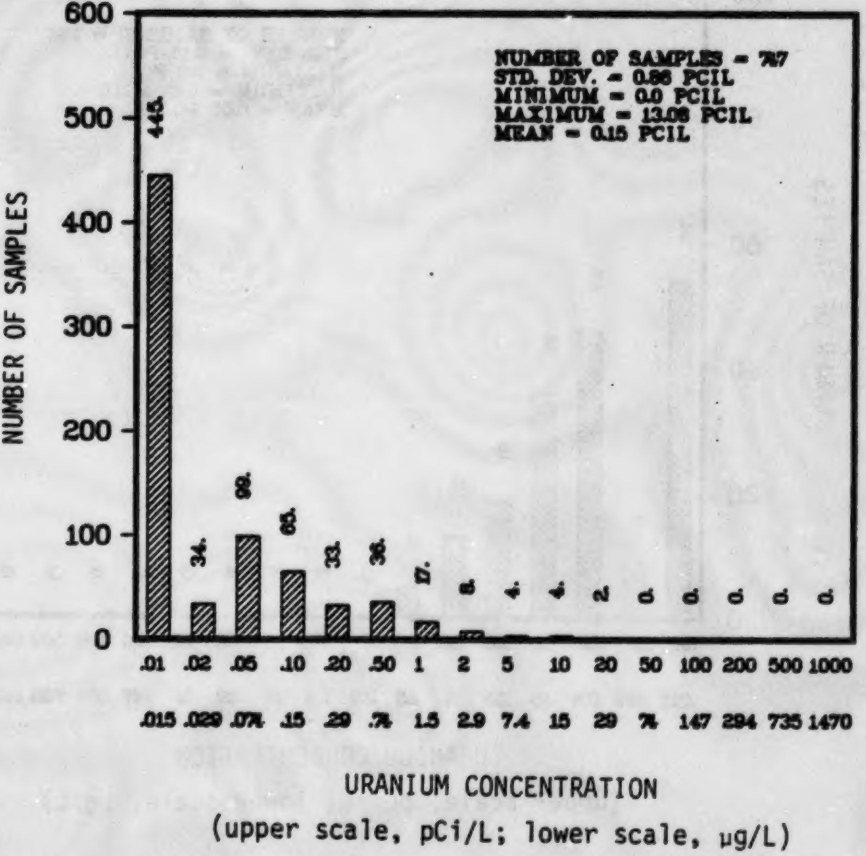


Fig. 3.161. Histogram of uranium concentrations in ground waters of Tennessee.

3.43.2.3 Established Domestic and Municipal Waters — One hundred eighty-two Tennessee sites were identified as domestic or municipal water sources. The concentrations of uranium in these waters ranged from 0.01 to 0.82 pCi/L and averaged 0.08 pCi/L. The median and modal concentrations were the same, 0.01 pCi/L (Fig. 3.162).

3.43.2.4 Treated Waters from Municipal Water Purification Plants — The concentrations of uranium in treated waters from all listed Tennessee municipal water purification plants were low. Uranium in the processed waters from the Nashville treatment plant and from the Allen, Sheahan, McCord, and Parkway filtration plants in Memphis was below the limit of

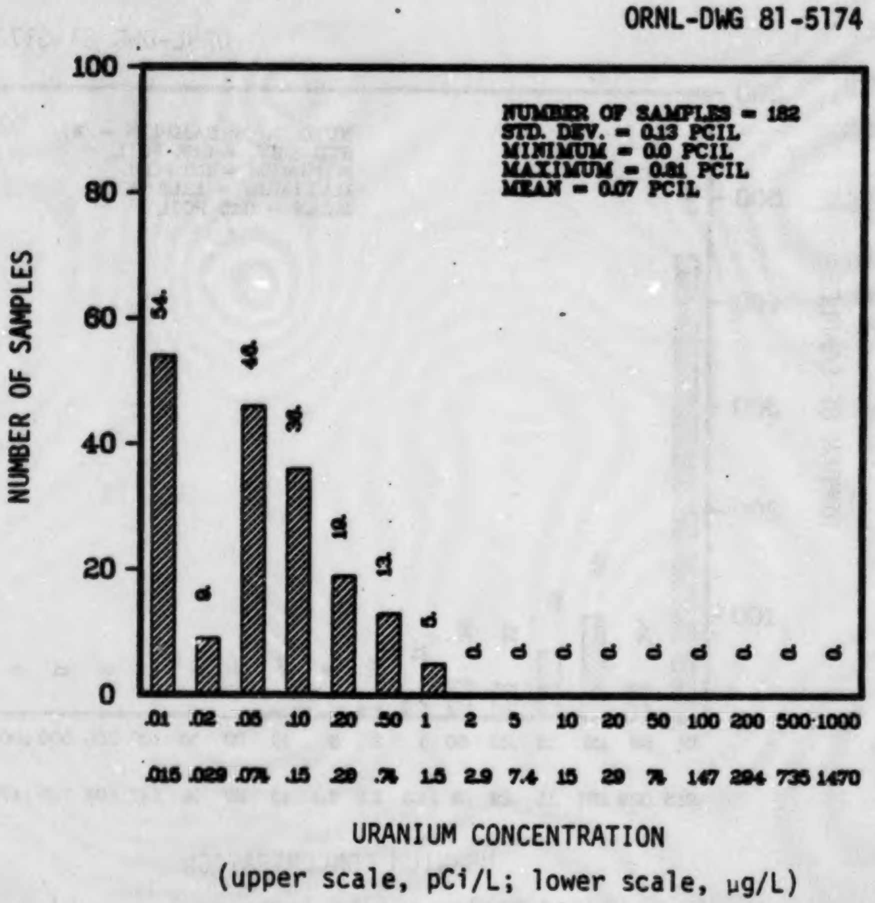


Fig. 3.162. Histogram of uranium concentrations in domestic waters of Tennessee.

detection (<0.07 pCi/L) in 1961. Water from the Chattanooga plant contained only slightly more uranium, 0.2 pCi/L. In 1977 a July to December composite sample of water from the Knoxville municipal treatment plant [1] contained 0.036, 0.001, 0.025 pCi/L of $^{234}$U, $^{235}$U, and $^{238}$U, respectively. The total uranium activity of this sample was 0.062 pCi/L.

### 3.43.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Tennessee domestic water was estimated to be <0.1 pCi/L, 17th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.43.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% of Tennessee water supplies contain uranium in excess of 1 pCi/L.

## 3.44 URANIUM IN TEXAS WATERS

### 3.44.1 Extent of Coverage

NURE data were available for about 55% of the state, chiefly the northwestern, southern, and southeastern sectors [59,96,97,100-102,107, 108,110-112,117-120,124]. Few assays were found for sources located in the northeastern, central, and southwestern portions of the state [15], but analyses were obtained for treated waters from municipal water treatment plants in the nine largest cities [26]. Overall, 11 536 surface and ground water sites were surveyed (Fig. 3.163).

### 3.44.2 Concentrations of Uranium in Samples

3.44.2.1 Surface Waters — Uranium in 1169 Texas surface waters ranged from 0.01 to 104.99 pCi/L and averaged 1.51 pCi/L. The median surface water concentration range was 0.2 to 0.5 pCi/L, and the modal concentration range was 0.1 to 0.2 pCi/L (Fig. 3.164).

3.44.2.2 Ground Waters — The concentrations of uranium in 10 367 Texas ground water samples varied from 0.01 to 356.32 pCi/L and averaged 3.75 pCi/L. The median concentration range for Texas ground waters was 0.5 to 1 pCi/L. The modal concentration range was somewhat lower, 0.1 to 0.2 pCi/L (Fig. 3.165).

3.44.2.3 Established Domestic and Municipal Waters — Of the Texas sites 6320 were identified as domestic or municipal sources. Uranium in these waters varied from 0.01 to 356.32 pCi/L and averaged 2.99 pCi/L. The median and modal concentration ranges among these sample were 0.2 to 0.5 pCi/L and 0.1 to 0.2 pCi/L, respectively (Fig. 3.166).

3.44.2.4 Treated Waters from Municipal Water Purification Plants — Treated water from municipal plants in larger Texas cities generally contained low concentrations of uranium, except for cities located in

ORNL-DWG 81-5243

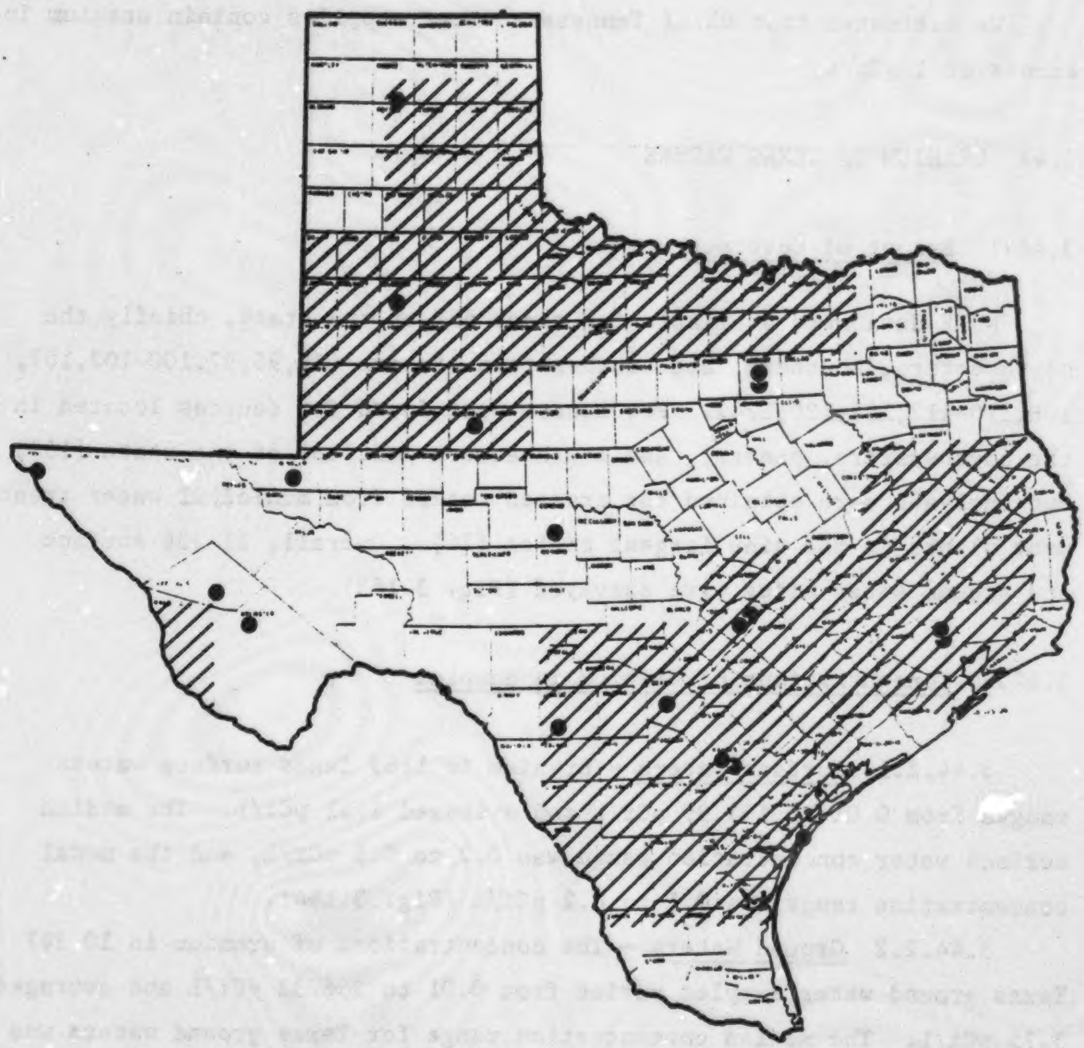


Fig. 3.163. Locations of sample sites in Texas.

the panhandle and in the extreme western sector. Thus, concentrations of uranium were below the limit of detection (<0.07 pCi/L) in treated waters from Austin and were only 0.14, 0.14, and 0.20 pCi/L for the Elm Fork, Bachman, and Lake Lavon treatment plants in Dallas. Water from the Corpus Christi, Fort Worth, and San Antonio plants contained 0.61, 0.95, and 0.20 pCi/L, respectively. Samples from the Heights, East End, and Southwest well fields in Houston assayed 2.44, 0.77, and 1.50 pCi/L

ORNL-DWG 81-5175

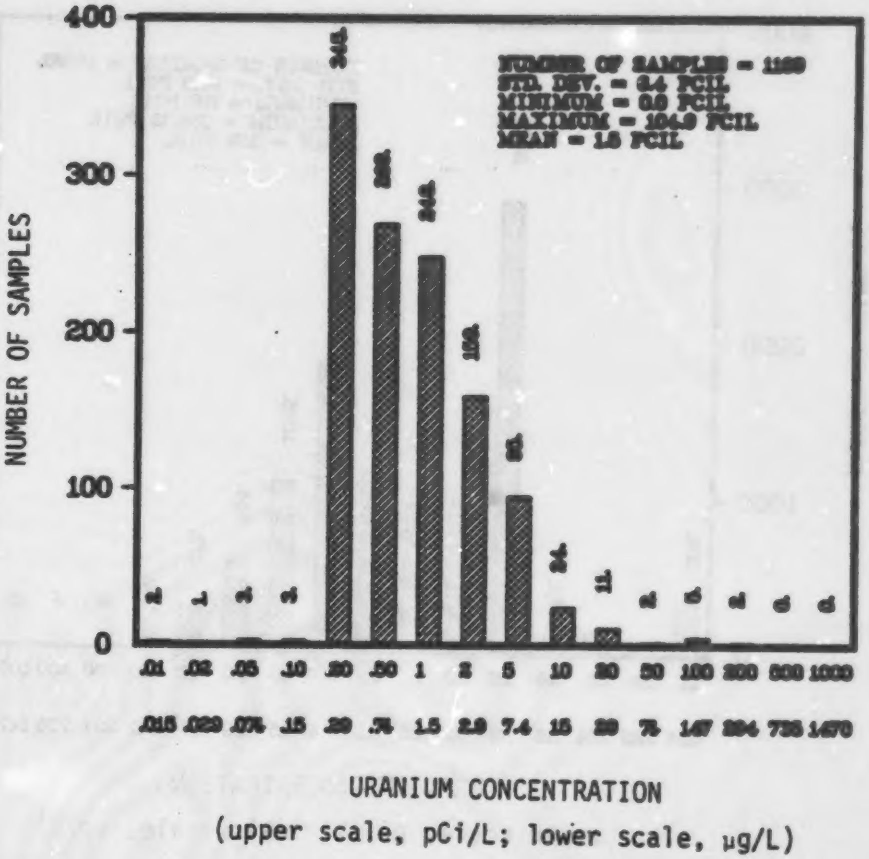


Fig. 3.164. Histogram of uranium concentrations in surface waters of Texas.

uranium, respectively, but water from the San Jacinto purification plant in Houston contained only 0.07 pCi/L uranium. On the other hand, water from Southwest and Carson County well fields in Amarillo contained 5.03 and 3.33 pCi/L uranium, respectively. Similarly, water from the Rio Grande treatment plant, Mesa Station, Canutillo Station, Airport Station, Nevins Station, and Well V-70 in El Paso contained 1.56, 2.31, 0.07, 3.67, 1.97, and 3.20 μg/L uranium, respectively. Water from the Lubbock well fields contained the highest concentrations of uranium recorded for metropolitan sources in Texas; samples from the Northeast Sand Hills, and Shallowater well fields of this city assayed 8.84, 2.04, and 170

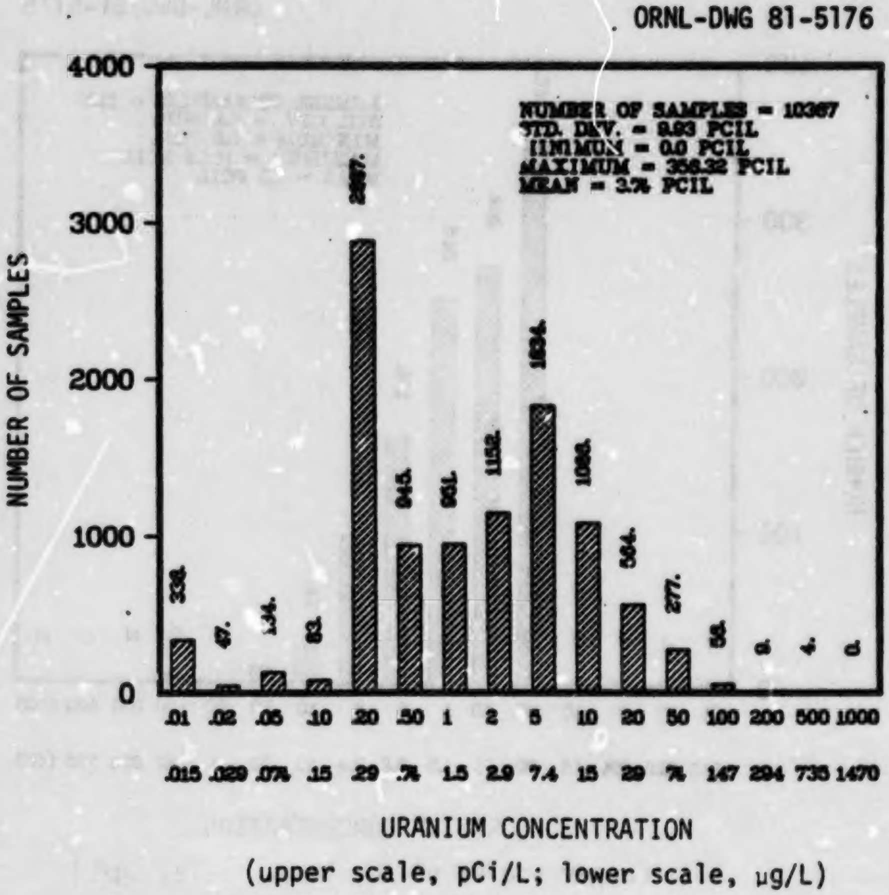


Fig. 3.165. Histogram of uranium concentrations in ground waters of Texas.

pCi/L uranium, respectively. The latter water source contributed about 10% of the water consumed in the Lubbock system in 1962.

### 3.44.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Texas domestic waters was estimated to be 2.6 pCi/L, 5th highest among all states (Appendix 2). The correponding alpha radiation bone dose was 39 mrem/year for Model I and 1 mrem/year for Model II.

In view of the extraordinarily high concentrations recorded for some Texas samples, a few comments about sources of contamination in Texas waters may be appropriate here.

ORNL-DWG 81-5177

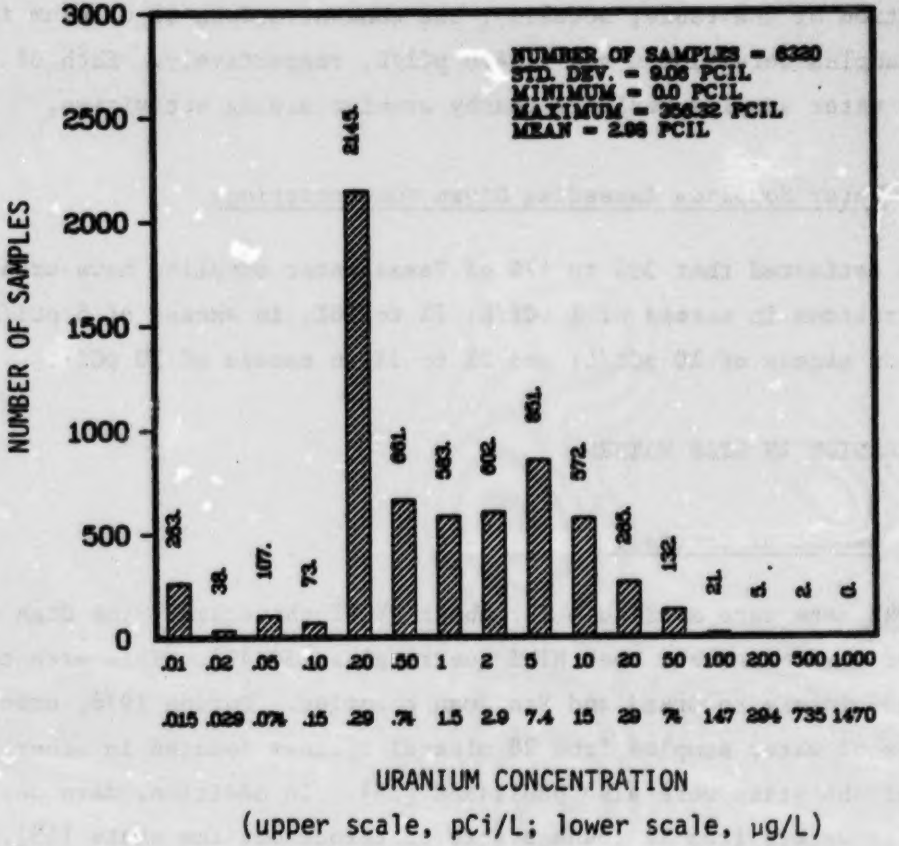


Fig. 3.166. **Histogram of uranium concentrations in domestic waters of Texas.**

The Amarillo and Lubbock water systems contained higher concentrations of uranium than those of any other large metropolitan city in Texas. Both of these cities obtain raw water from deep wells. No commercial deposits of uranium are located near these wells, but some uranium mineralization has been documented in the vicinity [97,124]. Undoubtedly, such mineralization accounts for the elevated concentrations of uranium in the municipal water systems of Amarillo and Lubbock, as well as El Paso.

Two samples in the Texas table Y100750 and Y100753 were listed with uranium concentrations of 999.99 pCi/L. These values are the largest that could be indicated with the computer format that was used in the preparation of the table; actually, the concentrations of uranium in these samples were 1138.0 and 2184.0 pCi/L, respectively. Each of these surface water samples reflects nearby uranium mining activities.

### 3.44.4 Water Supplies Exceeding Given Concentrations

We estimated that 39% to 47% of Texas water supplies have uranium concentrations in excess of 1 pCi/L; 7% to 16%, in excess of 5 pCi/L; 3% to 7%, in excess of 10 pCi/L; and 2% to 3% in excess of 20 pCi/L.

## 3.45 URANIUM IN UTAH WATERS

### 3.45.1 Extent of Coverage

NURE data were available for about 9% of the state: the Utah portions of the Cortez and Moab NTMS quadrangles [30,40]. This area corresponds closely to Grand and San Juan counties. During 1978, uranium analyses of water samples from 28 mineral springs located in other portions of the state were also published [17]. In addition, data were found for waters from 12 towns scattered throughout the state [15], including treated waters from the municipal system in Salt Lake City [26]. Overall, pertinent analyses of 608 Utah surface and ground water samples were located (Fig. 3.167).

### 3.45.2 Concentration of Uranium in Samples

3.45.2.1 Surface Waters — The concentrations of uranium in 260 Utah surface water samples ranged from 0.01 to 300.01 pCi/L and averaged 4.31 pCi/L. The median and modal concentration ranges for this subset were identical, 0.1 to 0.2 pCi/L (Fig. 3.168).

3.45.2.2 Ground Waters — In 348 Utah ground water samples the concentrations of uranium ranged from 0.01 to 116.58 pCi/L and averaged 2.16 pCi/L. The median and modal concentration ranges for Utah ground waters were the same, 0.5 to 1 pCi/L (Fig. 3.169).

ORNL-DWG 81-5244

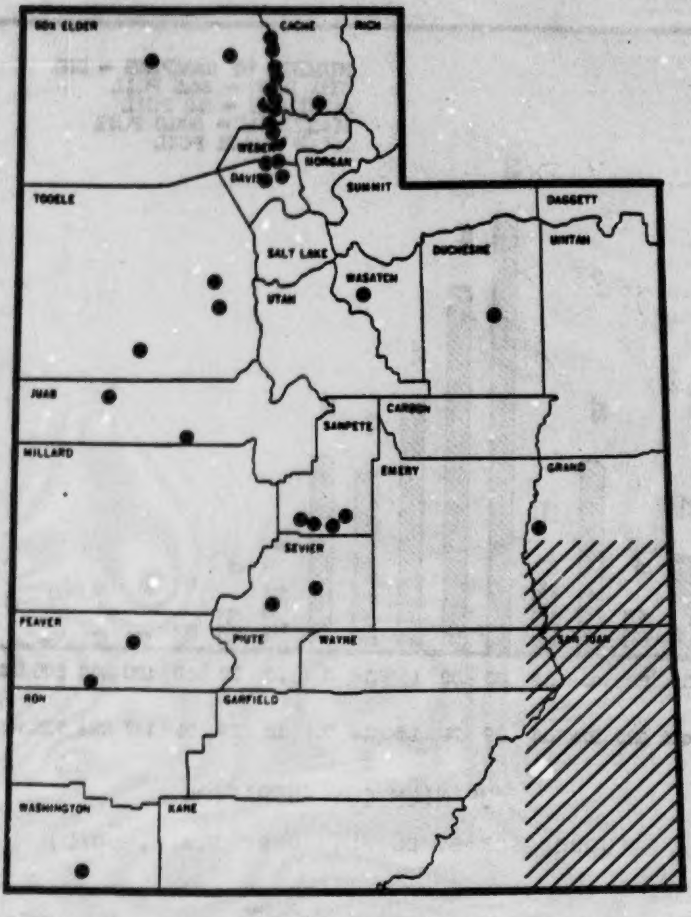

BOX ELDER
CACHE
RICH
WEBER
MORGAN
DAVIS
SUMMIT
TOOELE
DAGGETT
UINTAH
SALT LAKE
WASATCH
DUCHESNE
UTAH
JUAB
CARBON
SANPETE
MILLARD
EMERY
GRAND
SEVIER
BEAVER
PIUTE
WAYNE
SAN JUAN
IRON
GARFIELD
WASHINGTON
KANE

Fig. 3.167. Locations of sample sites in Utah.

3.45.2.3 Established Domestic and Municipal Waters — Fifteen of the Utah sites were identified as domestic or municipal water sources. The concentrations of uranium in these waters ranged from 0.07 to 4.01 pCi/L and averaged 1.21 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L (Fig. 3.170).

3.45.2.4 Treated Waters from Municipal Water Purification Plants — Data for treated water from municipal water purification plants were obtained only for the five facilities serving Salt Lake City. The concentrations of uranium in water from these plants in 1961 were as follows (pCi/L): Little Cottonwood, 0.5; Big Cottonwood, 0.3; Mountain Dell, 0.3; City Creek, 0.5; and 3rd East Station, 1.9.

ORNL-DWG 81-5178

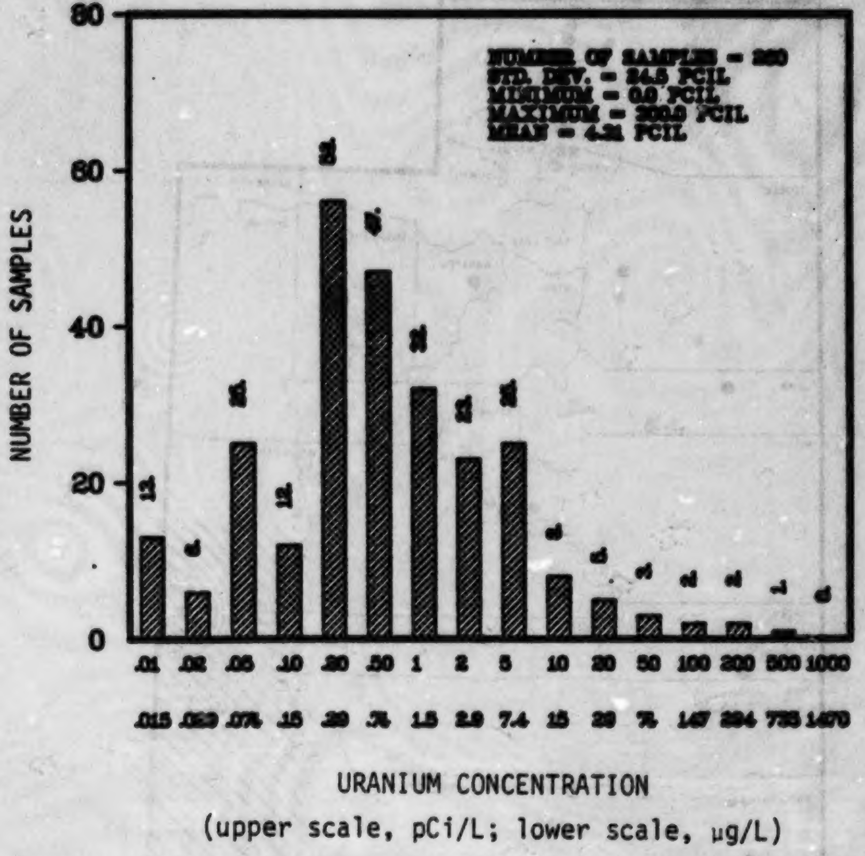


Fig. 3.168. Histogram of uranium concentrations in surface waters of Utah.

### 3.45.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Utah domestic waters was estimated to be 0.5 pCi/L, 13th highest among all states (Appendix 2). The alpha radiation bone dose computed from this average was 8 mrem/year for Model I and <1 mrem/year for Model II.

### 3.45.4 Water Supplies Exceeding Given Concentrations

Based on a limited number of samples, we estimated that 20% to 33% of Utah water supplies have uranium concentrations exceeding 1 pCi/L and 0%, exceeding 5 pCi/L. However, in view of the relatively great

ORNL-DWG 81-5179

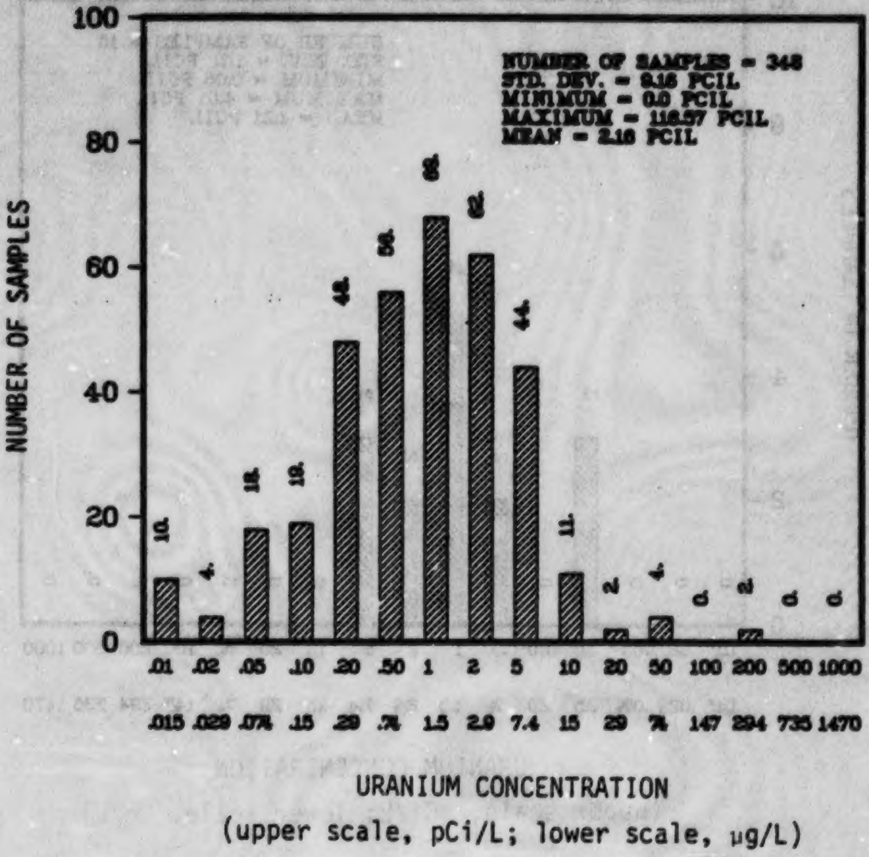


Fig. 3.169. Histogram of uranium concentrations in ground waters of Utah.

range of Utah surface and ground water concentrations, we consider it likely that if more domestic water data were available the estimates stated above would increase to 0% to 10% exceeding 5 pCi/L and perhaps 0% to 5% exceeding 10 pCi/L.

## 3.46 URANIUM IN VERMONT WATERS

### 3.46.1 Extent of Coverage

NURE data were available for the southern half of Vermont [79,82] (Fig. 3.171). Overall, 1097 surface and ground water sources were surveyed.

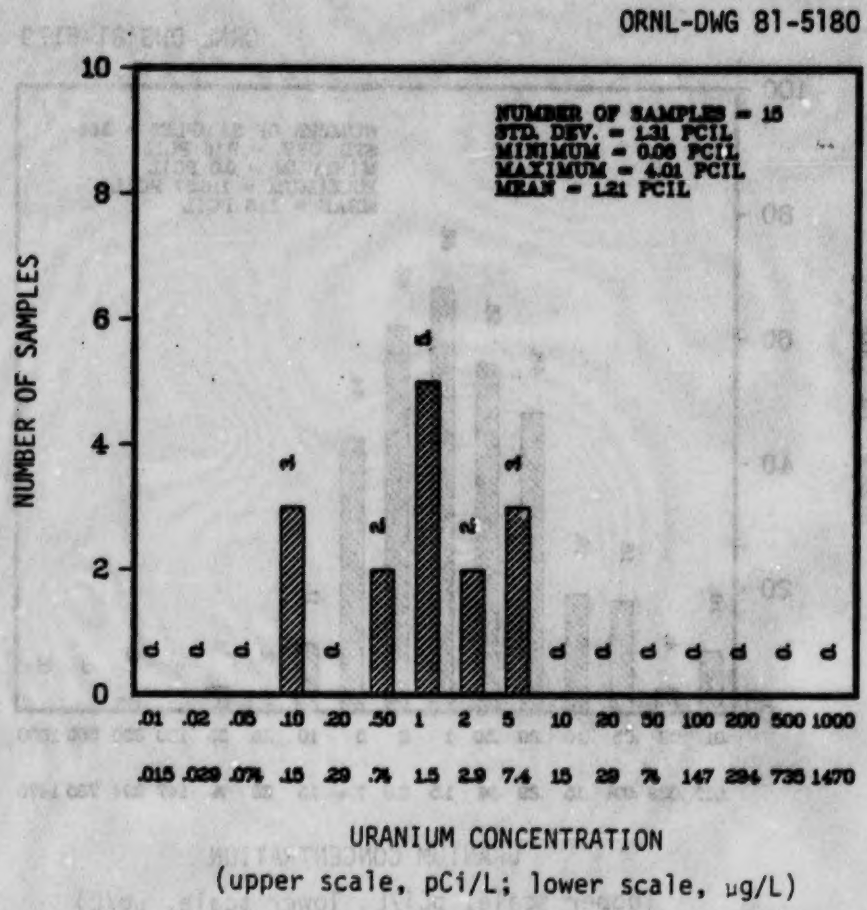


Fig. 3.170. Histogram of uranium concentrations in domestic waters of Utah.

### 3.46.2 Concentrations of Uranium in Samples

3.46.2.1 Surface Waters — Concentrations of uranium in 699 Vermont surface water samples ranged from 0.01 to 5.88 pCi/L and averaged 0.11 pCi/L. The median concentration range for this subset of samples was 0.02 to 0.05 pCi/L, but the modal concentration was somewhat lower, 0.01 pCi/L (Fig. 3.172).

3.46.2.2 Ground Waters — Uranium in 398 Vermont ground water samples ranged from 0.01 to 14.86 pCi/L and averaged 0.46 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L; however, the modal concentration was considerably lower, 0.01 pCi/L (Fig. 3.173).

ORNL-DWG 81-5245

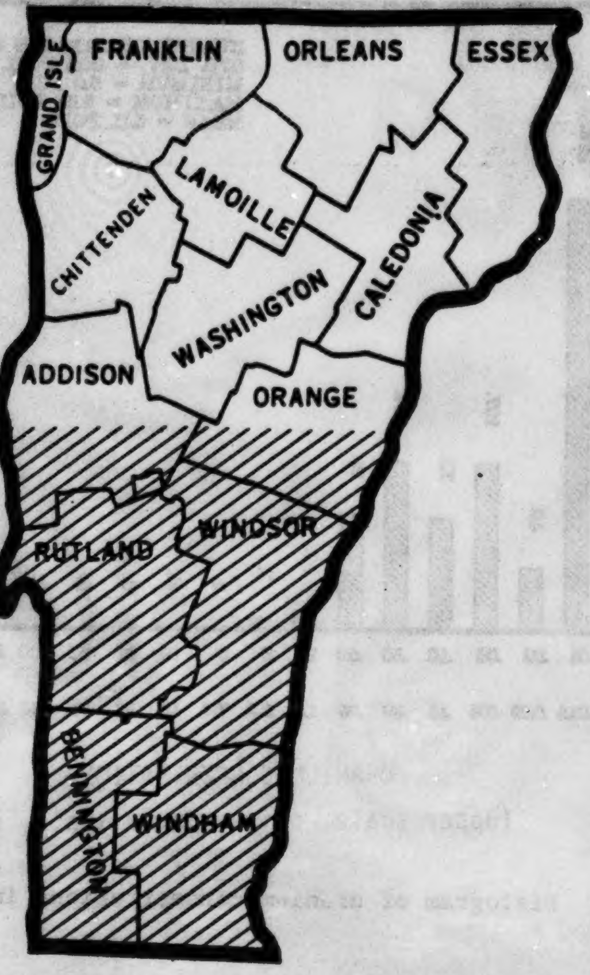

GRAND ISLE
FRANKLIN
ORLEANS
ESSEX
LAMOILLE
CHITTENDEN
CALEDONIA
WASHINGTON
ADDISON
ORANGE
WINDSOR
RUTLAND
BENNINGTON
WINDHAM

Fig. 3.171. Locations of sample sites in Vermont.

3.46.2.3 Established Domestic and Municipal Waters — Of the listed Vermont sites 375 were identified as domestic or municipal water sources. The concentrations of uranium in these samples ranged from 0.01 to 14.86 pCi/L and averaged 0.42 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L, but the mode was 0.01 pCi/L (Fig. 3.174).

3.46.2.4 Treated Waters from Municipal Water Purification Plants — None of the Vermont samples was identified as treated water from a municipal water purification plant.

ORNL-DWG 81-5181

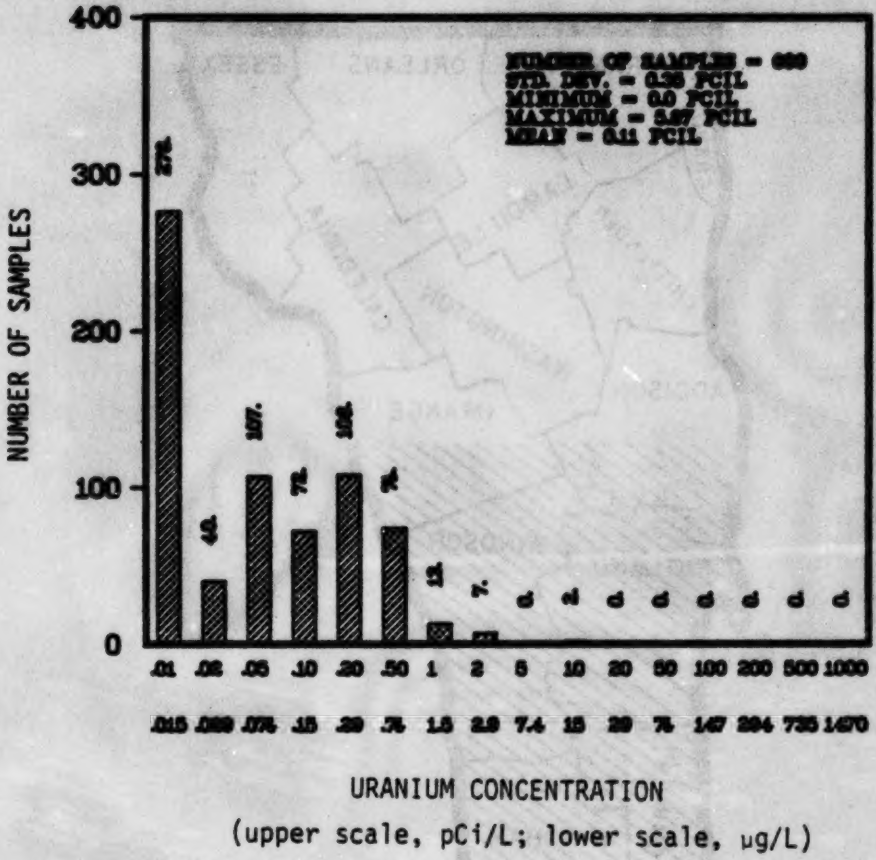


Fig. 3.172. Histogram of uranium concentrations in surface waters of Vermont.

### 3.46.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Vermont domestic waters was estimated to be <0.1 pCi/L, 17th highest among all states. The alpha radiation bone dose associated with this average was 1 mrem/year for Model I and <1 mrem/year for Model II.

### 3.46.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% to 9% of Vermont water supplies have uranium concentrations in excess of 1 pCi/L; 0% to 2%, in excess of 5 pCi/L; 0% to 0.5%, in excess of 10 pCi/L; and 0%, in excess of 20 pCi/L.

ORNL-DWG 81-5182

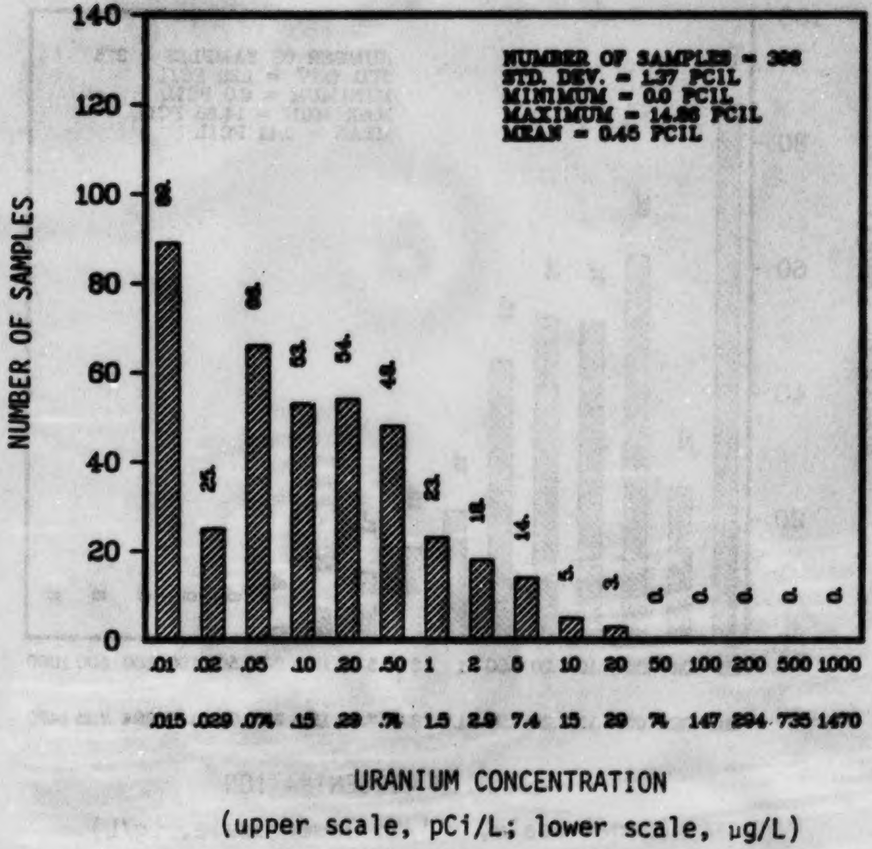


Fig. 3.173. Histogram of uranium concentrations in ground waters of Vermont.

## 3.47 URANIUM IN VIRGINIA WATERS

### 3.47.1 Extent of Coverage

NURE data were available for about 20% of Virginia, chiefly the south-central sector [66,68]. Analyses were also found for waters from five towns in the eastern portion of the state [15] and for treated waters from the three largest municipal water systems in the state [26]. Overall, 1035 surface and ground water sites were surveyed (Fig. 3.175).

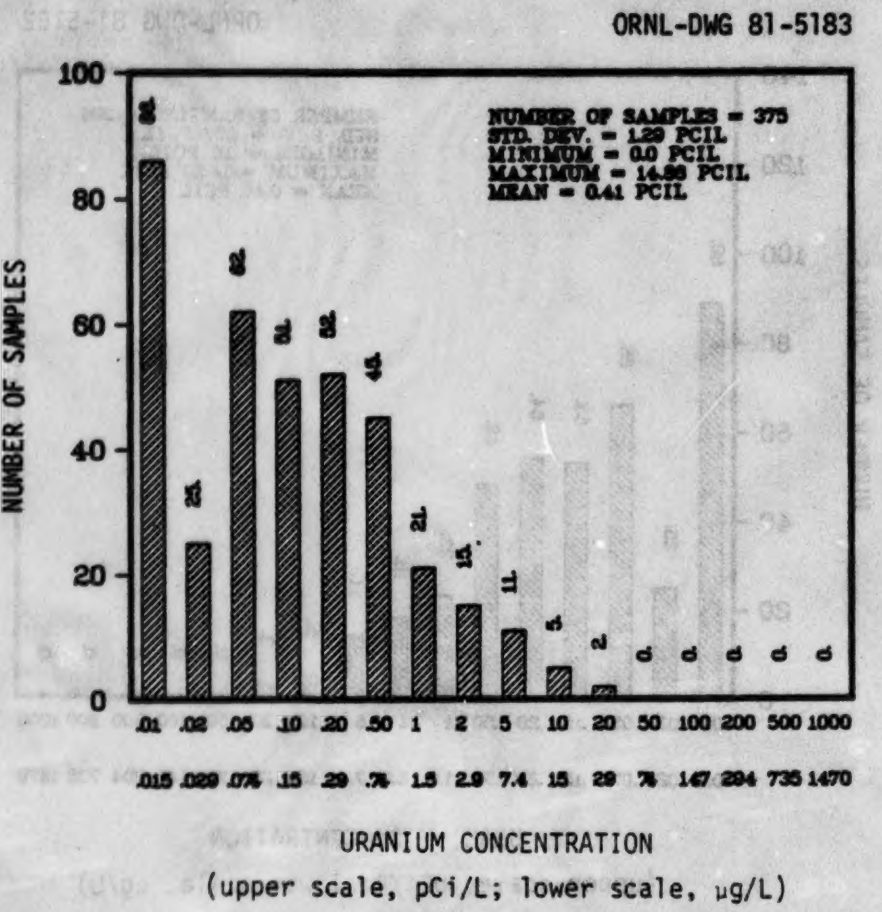


Fig. 3.174. Histogram of urnaium concentrations in domestic waters of Vermont.

### 3.47.2 Concentration of Uranium in Samples

3.47.2.1 Surface Waters — Only three Virginia samples were identified as surface water. Uranium in this small subset ranged from 0.07 to 0.14 pCi/L and averaged 0.09 pCi/L. The median and modal concentration ranges were 0.05 to 0.1 pCi/L (Fig. 3.176).

3.47.2.2 Ground Waters — One thousand thirty-two Virginia ground water analyses were recorded. The concentrations of uranium in these samples ranged from 0.01 to 495.99 pCi/L and averaged 1.16 pCi/L. The median and modal concentration ranges were identical, 0.02 to 0.05 pCi/L (Fig. 3.177).

ORNL-DWG 81-5246

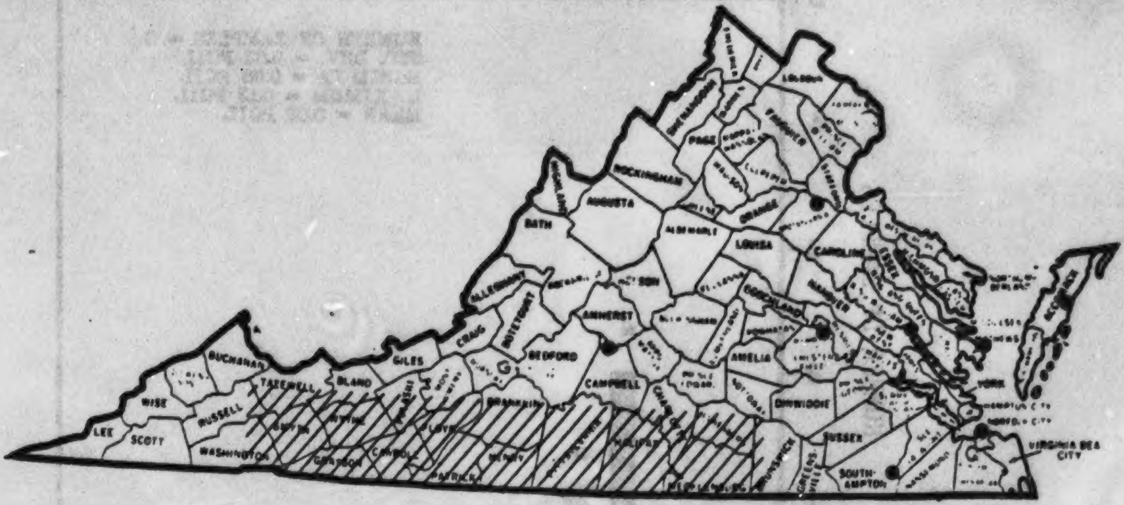

LOUDOUN
PAGE
ROCKINGHAM
AUGUSTA
BATH
ALBEMARLE
LOUISA
CAROLINE
HANOVER
AMHERST
BEDFORD
CAMPBELL
CRAIG
GILES
BLAND
TAZEWELL
BUCHANAN
WISE
RUSSELL
LEE
SCOTT
WASHINGTON
GRAYSON
CARROLL
PATRICK
HENRY
FRANKLIN
AMELIA
DINWIDDIE
SUSSEX
SOUTH-AMPTON
YORK
VIRGINIA BEA CITY

Fig. 3.175. Locations of sample sites in Virginia.

3.47.2.3 Established Domestic and Municipal Waters — Of the listed Virginia sites 641 were identified as domestic or municipal sources. Concentrations of uranium in water from these sources ranged from 0.01 to 495.99 pCi/L and averaged 0.95 pCi/L. The median and modal concentration ranges were identical, 0.02 to 0.05 pCi/L (Fig. 3.178).

3.47.2.4 Treated Waters from Municipal Water Purification Plants — Concentrations of uranium in waters from the Moores Bridge and the 37th Street treatment plants in Norfolk were less than 0.07 pCi/L in 1962; that from the Douglasdale Road filtration plant in Richmond was also low, 0.14 pCi/L. A sample from the Lynchburg system, composited from July to December, 1977, contained 0.031, 0.003, and 0.031 pCi/L of $^{234}U$, $^{235}U$, and $^{238}U$, respectively [1]. The total uranium activity of this sample was 0.065 pCi/L.

## 3.47.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Virginia domestic waters was estimated as <0.1 pCi/L, 17th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 1 mrem/year for Model I and <1 mrem/year for Model II.

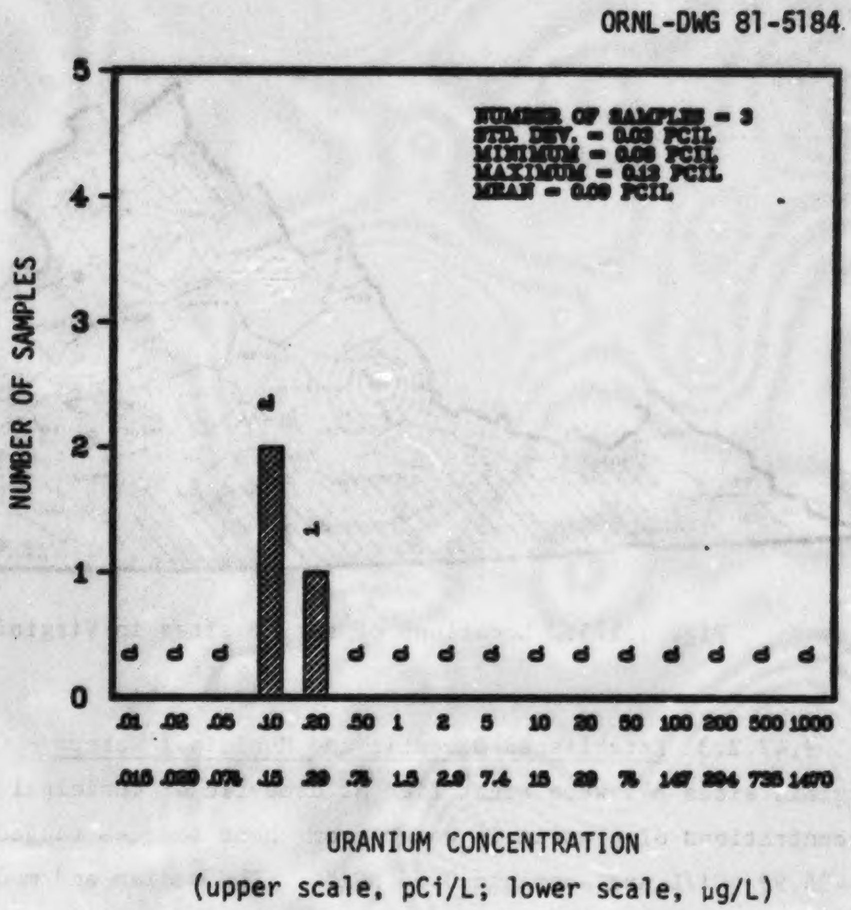


Fig. 3.176. Histogram of uranium concentrations in surface waters of Virginia.

### 3.47.4 Water Supplies Exceeding Given Concentrations

We estimated that 0% to 3% of Virginia water supplies have uranium concentrations in excess of 1 pCi/L; 0% to 0.6%, in excess of 5 pCi/L; 0% to 0.5%, in excess of 10 pCi/L; and 0% to 0.3%, in excess of 20 pCi/L.

## 3.48 URANIUM IN WASHINGTON WATERS

### 3.48.1 Extent of Coverage

Uranium analyses have been reported for only about 5% of the Washington waters. NURE data were available for Pend Oreille County

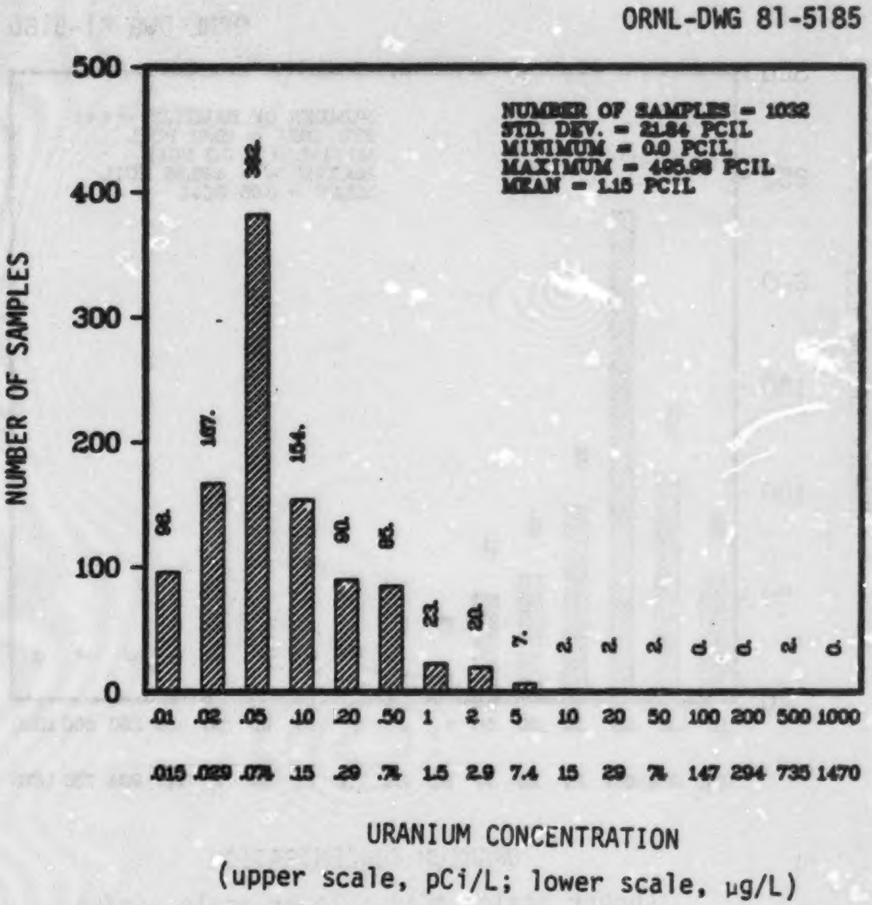


Fig. 3.177. Histogram of uranium concentrations in ground waters of Virginia.

and part of Stevens County [illegible]]. In addition, analyses were found for nine widely dispersed sources, including municipal water treatment plants in the three largest cities of the state [15,26]. Overall, 172 surface water and ground water sites were surveyed (Fig. 3.179).

### 3.48.2 Concentrations of Uranium in Samples

3.48.2.1 Surface Waters — Only two Washington samples were identified as surface water, and the concentration of uranium in each was low: 0.07 and 0.13 pCi/L (Fig. 3.180).

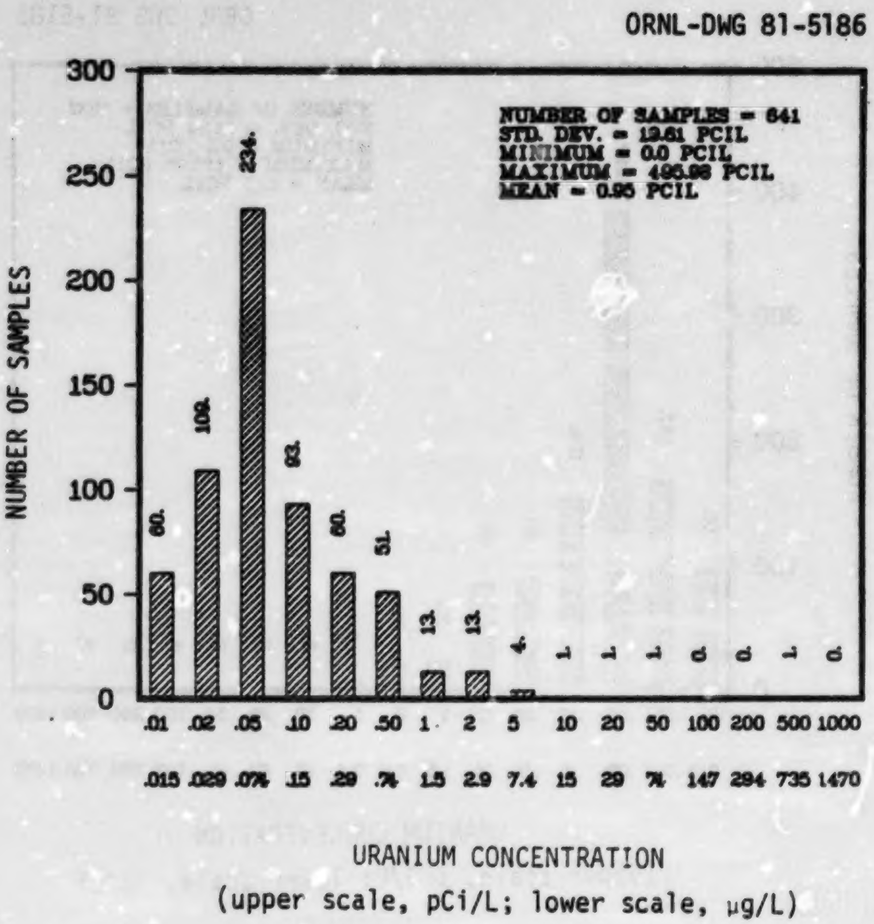


Fig. 3.178. Histogram of uranium concentrations in domestic waters of Virginia.

3.48.2.2 Ground Waters — The concentrations of uranium in 170 Washington ground waters varied from 0.01 to 40.12 pCi/L and averaged 2.75 pCi/L. The median and modal concentration ranges for these samples were identical, 0.5 to 1 pCi/L (Fig. 3.181).

3.48.2.3 Established Domestic and Municipal Waters — Eighty of the listed Washington sites were identified as domestic or municipal sources. The concentrations of uranium in these waters ranged from 0.01 to 26.72 pCi/L and averaged 1.92 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L (Fig. 3.182).

3.48.2.4 Treated Waters from Municipal Water Purification Plants — Finished waters from the Lake Youngs purification plant in Seattle and

ORNL-DWG 81-5247

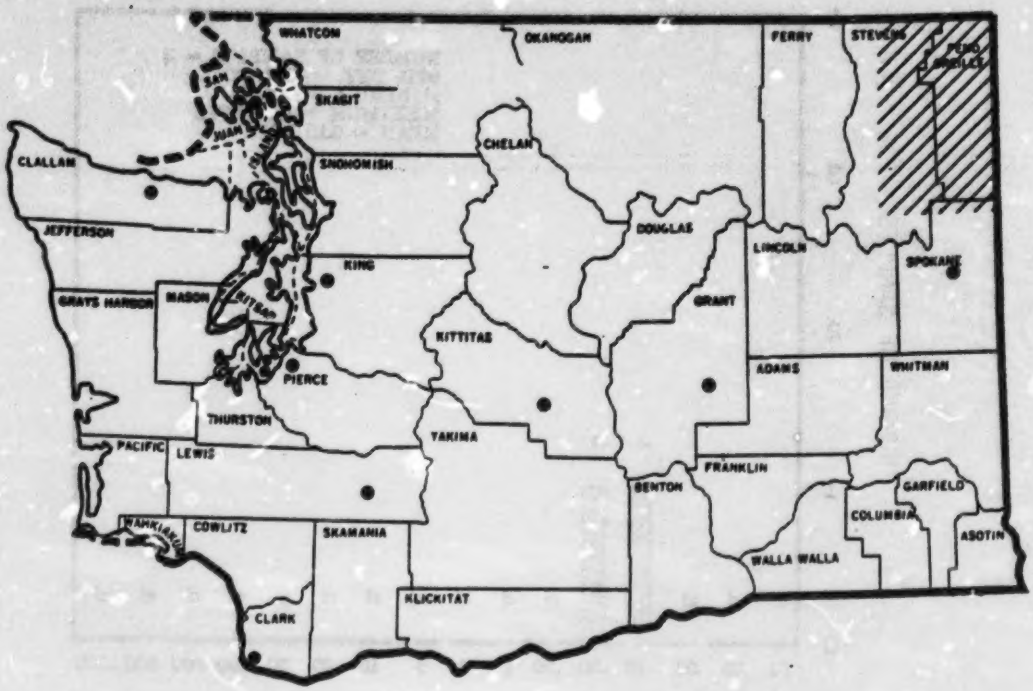

WHATCOM
OKANOGAN
FERRY
STEVENS
PEND OREILLE
SAN JUAN
SKAGIT
ISLAND
CLALLAM
SNOHOMISH
CHELAN
JEFFERSON
DOUGLAS
LINCOLN
SPOKANE
KING
GRAYS HARBOR
MASON
KITSAP
GRANT
KITTITAS
PIERCE
ADAMS
WHITMAN
THURSTON
YAKIMA
PACIFIC
LEWIS
FRANKLIN
BENTON
GARFIELD
COLUMBIA
WAHKIAKUM
COWLITZ
SKAMANIA
ASOTIN
WALLA WALLA
KLICKITAT
CLARK

Fig. 3.179. Locations of sample sites in Washington.

the treatment plant in Tacoma contained 0.07 and 0.14 pCi/L uranium, respectively. Water from Electric Well No. 2 in Spokane assayed 2.5 pCi/L uranium.

### 3.48.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Washington domestic waters was estimated to be 0.6 pCi/L, 12th highest among all states (Appendix 2). The alpha radiation bone dose computed from this average value was 9 mrem/year for Model I and <1 mrem/year for Model II.

### 3.48.4 Water Supplies Exceeding Given Concentrations

Based on measured and estimated concentrations of uranium in selected Washington water supplies and on the distribution of uranium

ORNL-DWG 81-5187

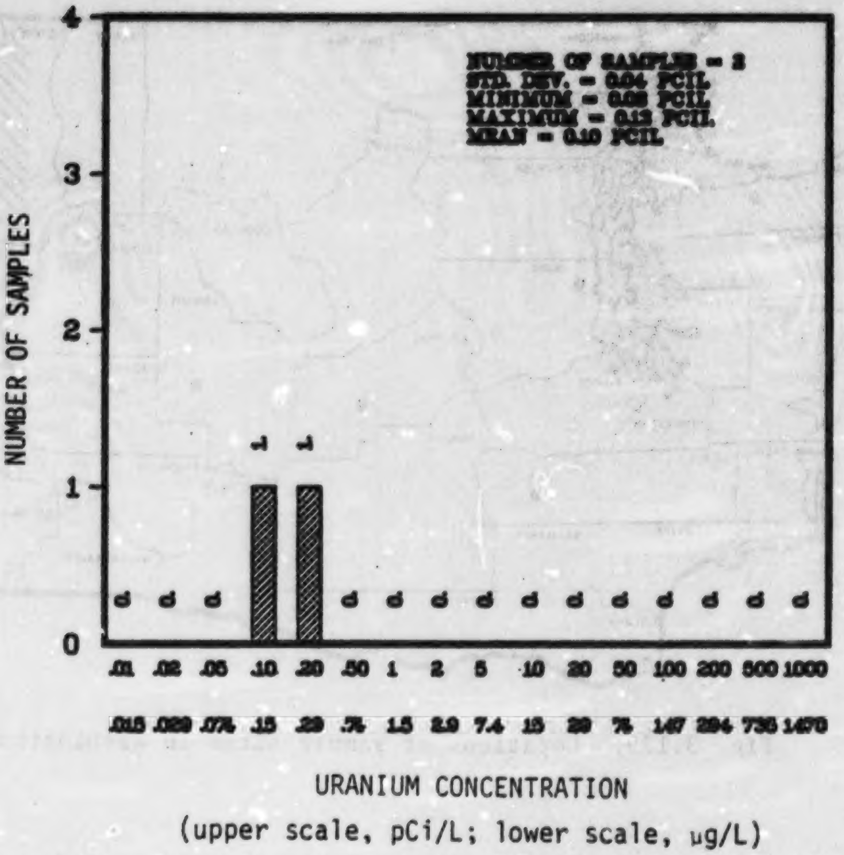


Fig. 3.180. Histogram of uranium concentrations in surface waters of Washington.

concentrations in the Washington domestic water histogram, we estimated that 10% to 41% of Washington water supplies contain uranium in excess of 1 pCi/L; 0% to 10%, in excess of 5 pCi/L; 0% to 3%, in excess of 10 pCi/L; and 0% to 1%, in excess of 20 pCi/L.

## 3.49 URANIUM IN WEST VIRGINIA WATERS

### 3.49.1 Extent of Coverage

No systematic surveys of uranium in West Virginia waters were available; data were found for only six ground water sites randomly scattered throughout the state [15] (Fig. 3.183).

ORNL-DWG 81-5188

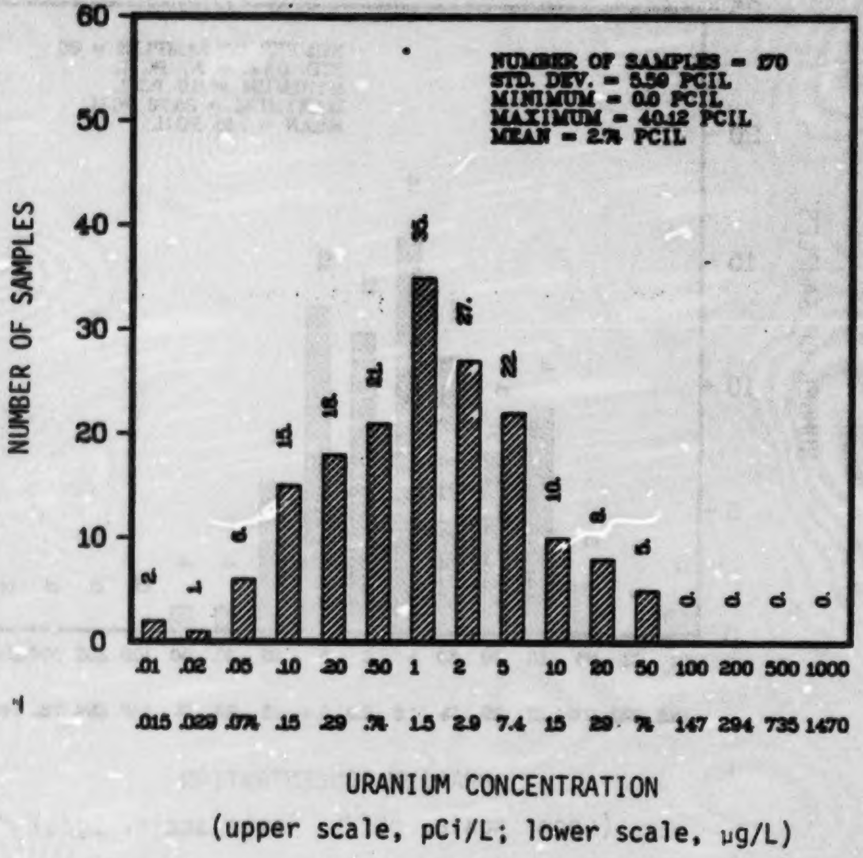


Fig. 3.181. Histogram of uranium concentrations in ground waters of Washington.

### 3.49.2 Concentrations of Uranium in Samples

3.49.2.1 Surface Waters — No data were available for West Virginia surface waters.

3.49.2.2 Ground Waters — The concentrations of uranium in the six listed West Virginia ground water samples ranged from 0.07 to 9.25 pCi/L and averaged 1.93 pCi/L. The median concentration range was 0.5 to 1 pCi/L. The most frequently occurring concentration ranges were 0.05 to 0.1 pCi/L and 0.5 to 1 pCi/L (Fig. 3.184). The highest-valued ground water sample was atypical, originating in a 1403-ft deep oil-brine well that was not used as a domestic water source. The average concentration

ORNL-DWG 81-5189

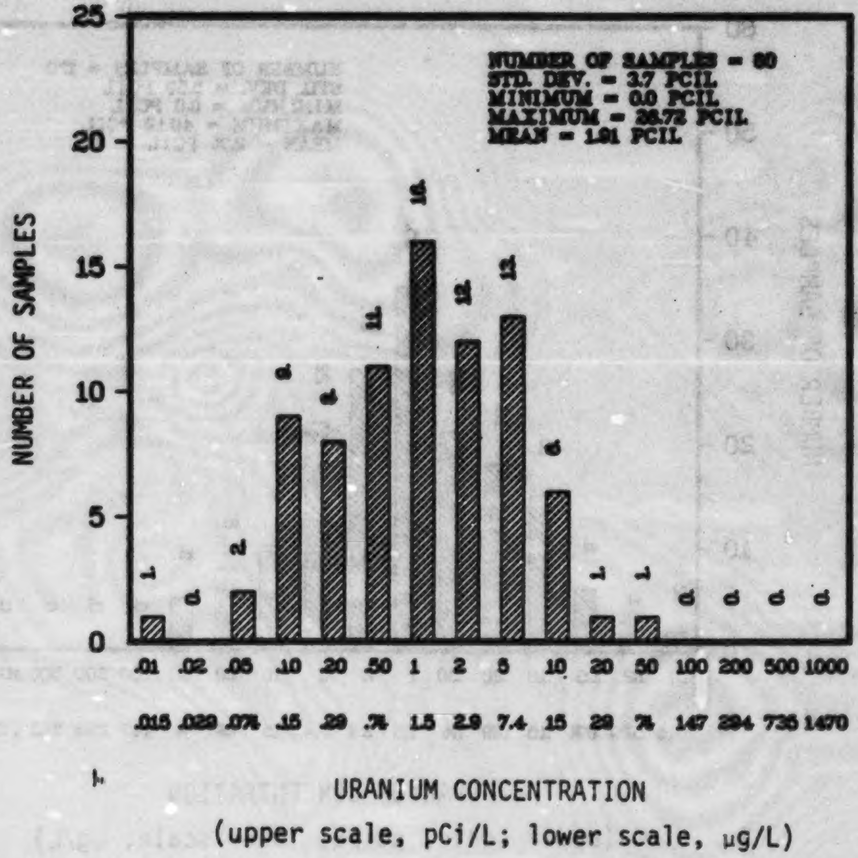


Fig. 3.182. Histogram of uranium concentrations in domestic waters of Washington.

of uranium in the West Virginia ground water samples excluding the oil-brine well value, was 0.34 pCi/L.

3.49.2.3 Established Domestic and Municipal Waters — Five of the six West Virginia sites were identified as municipal water sources. The concentrations of uranium in these waters ranged from 0.07 to 1.02 pCi/L and averaged 0.46 pCi/L. The median and modal concentration ranges were 0.5 to 1 pCi/L (Fig. 3.185).

3.49.2.4 Treated Waters from Municipal Water Purification Plants — It could not be established that any of the listed sources were treated by standard water purification procedures.

ORNL-DWG 81-5248

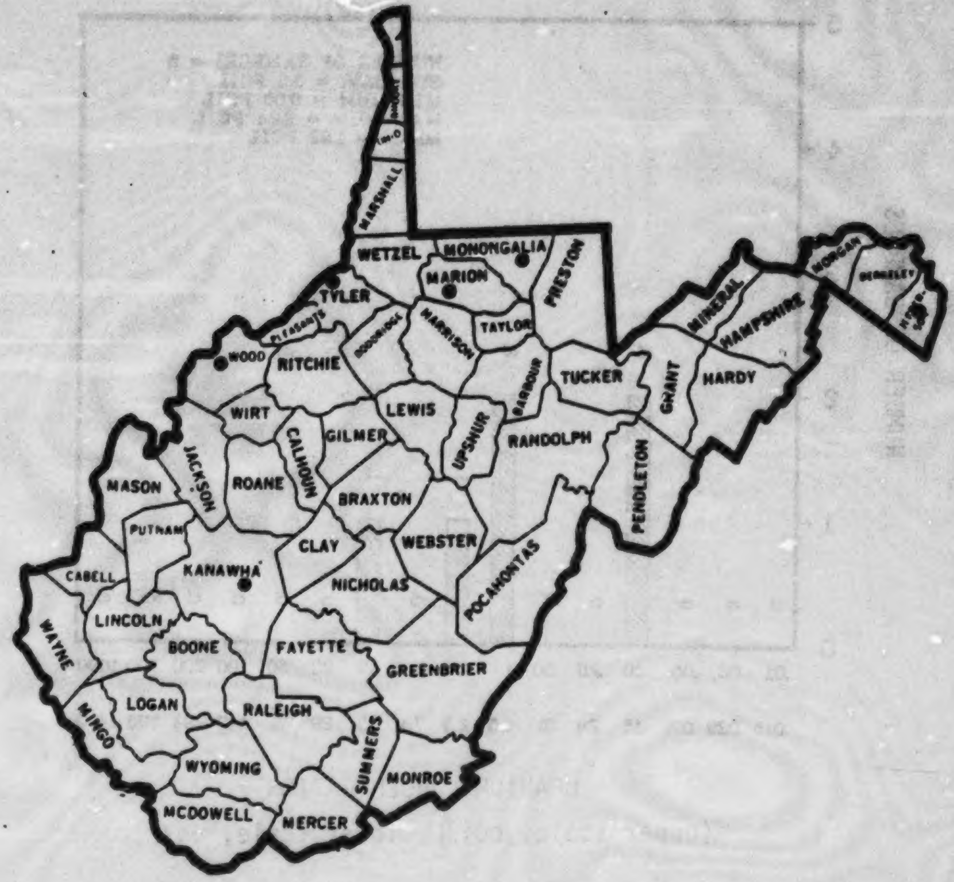

OHIO
MARSHALL
WETZEL
MONONGALIA
MARION
PRESTON
TYLER
PLEASANTS
WOOD
RITCHIE
DODDRIDGE
HARRISON
TAYLOR
BARBOUR
TUCKER
MINERAL
HAMPSHIRE
MORGAN
BERKELEY
GRANT
HARDY
WIRT
LEWIS
GILMER
CALHOUN
UPSHUR
RANDOLPH
MASON
JACKSON
ROANE
BRAXTON
PENDLETON
PUTNAM
CLAY
WEBSTER
CABELL
KANAWHA
NICHOLAS
POCAHONTAS
WAYNE
LINCOLN
BOONE
FAYETTE
GREENBRIER
LOGAN
RALEIGH
MINGO
SUMMERS
WYOMING
MONROE
MCDOWELL
MERCER

Fig. 3.183. Locations of sample sites in West Virginia.

### 3.49.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in West Virginia domestic waters was estimated to be 0.7 pCi/L, 11th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 11 mrem/year for Model I and <1 mrem/year for Model II.

### 3.49.4 Water Supplies Exceeding Given Concentrations

We estimated that 20% to 33% of West Virginia water supplies have uranium concentrations in excess of 1 pCi/L, but that 0% have uranium concentrations in excess of 5 pCi/L.

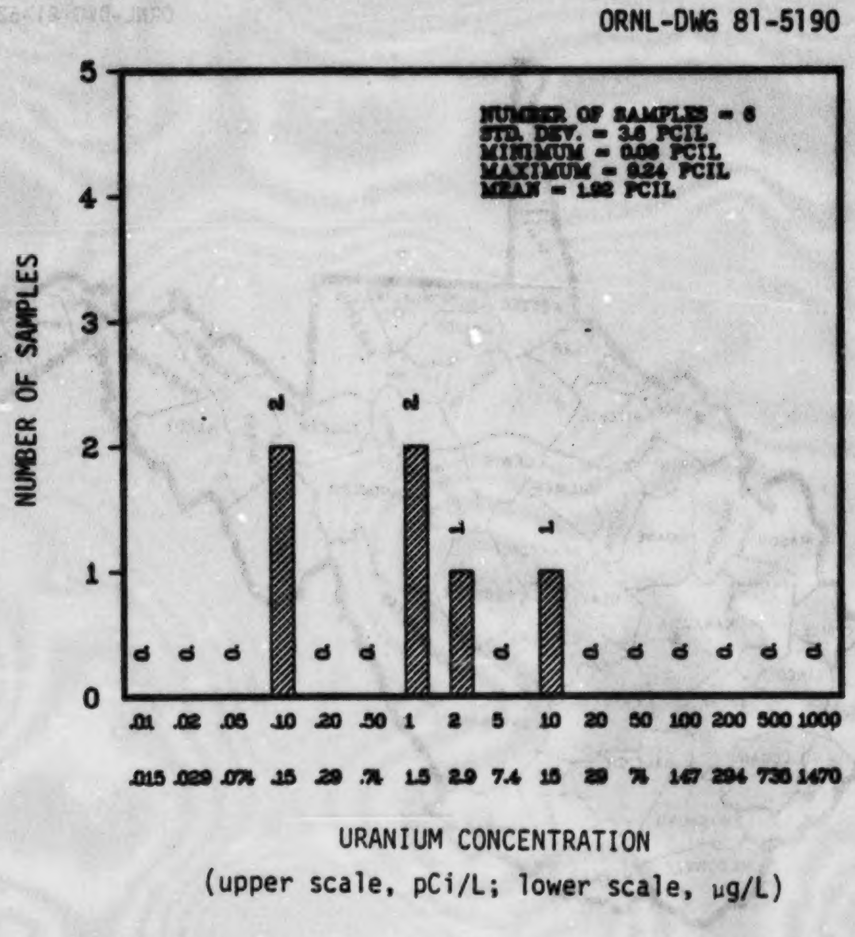


Fig. 3.184. Histogram of uranium concentrations in ground waters of West Virginia.

## 3.50 URANIUM IN WISCONSIN WATERS

### 3.50.1 Extent of Coverage

NURE data were available for almost two-thirds of the state, chiefly the portion north of the 44th parallel of latitude and east of 92° longitude [99,103,109,113,125]. Nearly a dozen additional analyses were also found [15,26], including treated waters from the two largest municipal systems in the state (Fig. 3.186). Overall, 4466 surface and ground water sites were surveyed.

ORNL-DWG 81-5191

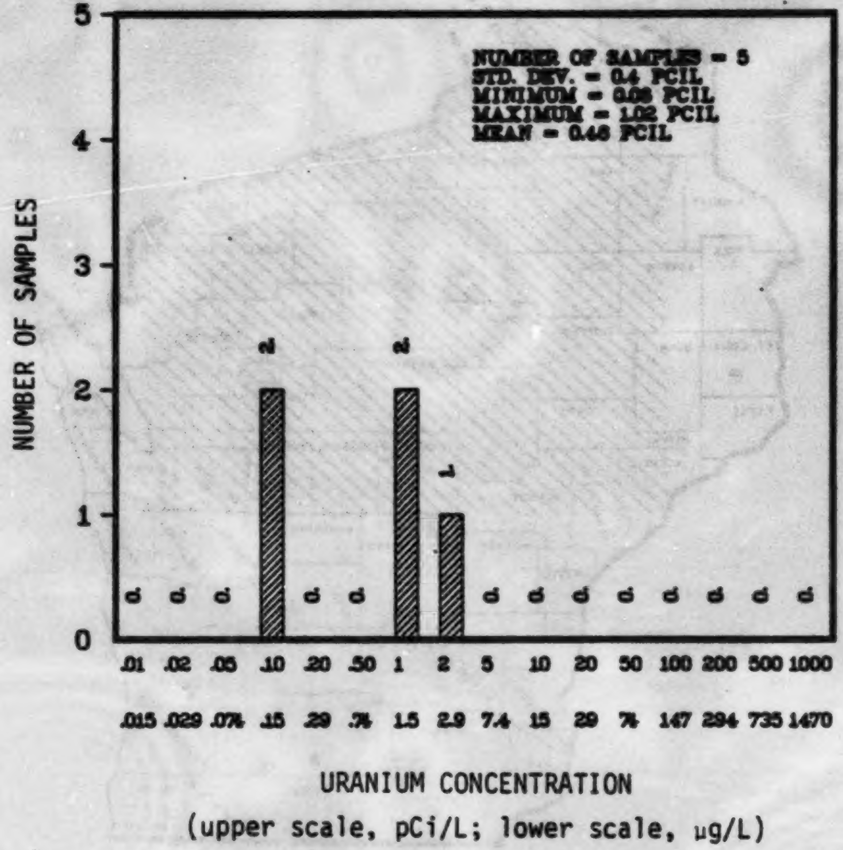


Fig. 3.185. Histogram of uranium concentrations in domestic waters of West Virginia.

### 3.50.2 Concentrations of Uranium in Samples

3.50.2.1 Surface Waters — The concentrations of uranium in 1966 Wisconsin surface water samples ranged from 0.01 to 67.99 pCi/L and averaged 0.55 pCi/L. The median concentration range was 0.02 to 0.05 pCi/L. The mode was 0.01 pCi/L (Fig. 3.187).

3.50.2.2 Ground Waters — Twenty-five hundred Wisconsin ground water analyses were found. The concentrations of uranium in these samples varied from 0.01 to 67.99 pCi/L and averaged 0.60 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L, and the modal concentration was 0.01 pCi/L (Fig. 3.188).

ORNL-DWG 81-5249

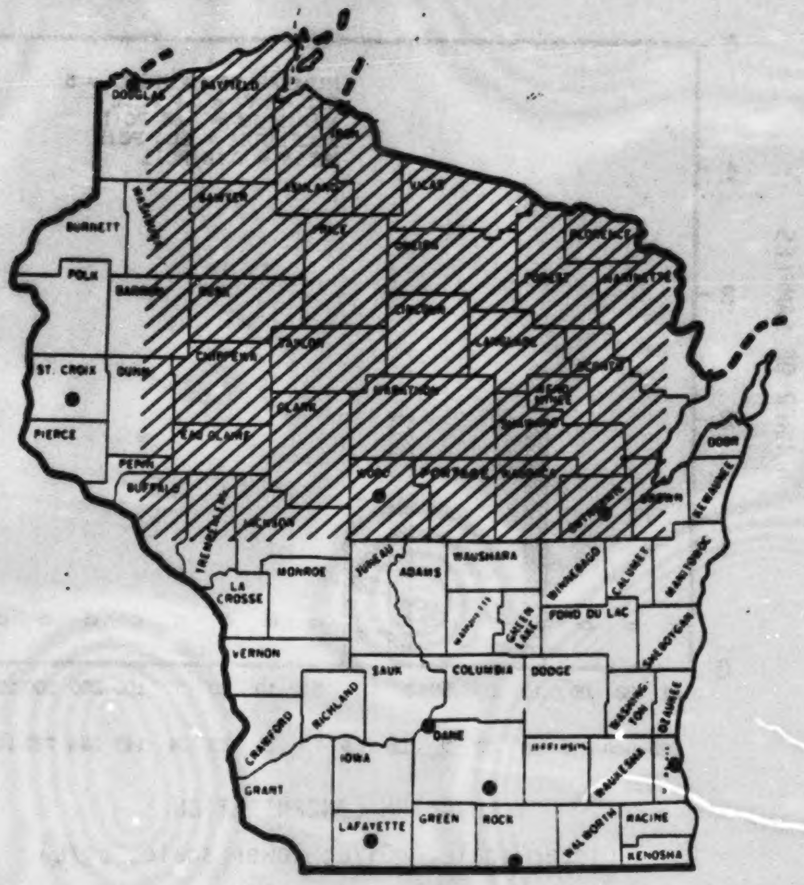

DOUGLAS
BAYFIELD
IRON
ASHLAND
VILAS
SAWYER
BURNETT
PRICE
ONEIDA
FLORENCE
POLK
BARRON
RUSK
FOREST
MARINETTE
LINCOLN
TAYLOR
CHIPPEWA
LANGLADE
OCONTO
ST. CROIX
DUNN
MARATHON
SHAWANO
CLARK
PIERCE
EAU CLAIRE
DOOR
PEPIN
BUFFALO
WOOD
PORTAGE
WAUPACA
OUTAGAMIE
BROWN
KEWAUNEE
TREMPEALEAU
JACKSON
JUNEAU
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MANITOWOC
MONROE
LA CROSSE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
SAUK
COLUMBIA
DODGE
OZAUKEE
WASHINGTON
RICHLAND
CRAWFORD
DANE
JEFFERSON
WAUKESHA
IOWA
GRANT
LAFAYETTE
GREEN
ROCK
WALWORTH
RACINE
KENOSHA

Fig. 3.186. Locations of sample sites in Wisconsin.

3.50.2.3 Established Domestic and Municipal Waters — Twenty-two hundred fifty-one Wisconsin water sites were identified as domestic water sources. The concentrations of uranium in these waters ranged from 0.01 to 67.99 pCi/L and averaged 0.60 pCi/L. The modal concentration was 0.01 pCi/L. The median concentration range was 0.05 to 0.1 pCi/L (Fig. 3.189).

3.50.2.4 Treated Waters from Municipal Water Purification Plants — The concentration of uranium in treated water from the Main Station in Madison was 0.34 pCi/L in 1961. A similar sample from the Linnwood Avenue purification plant in Milwaukee contained no detectable concentration of uranium (<0.07 pCi/L).

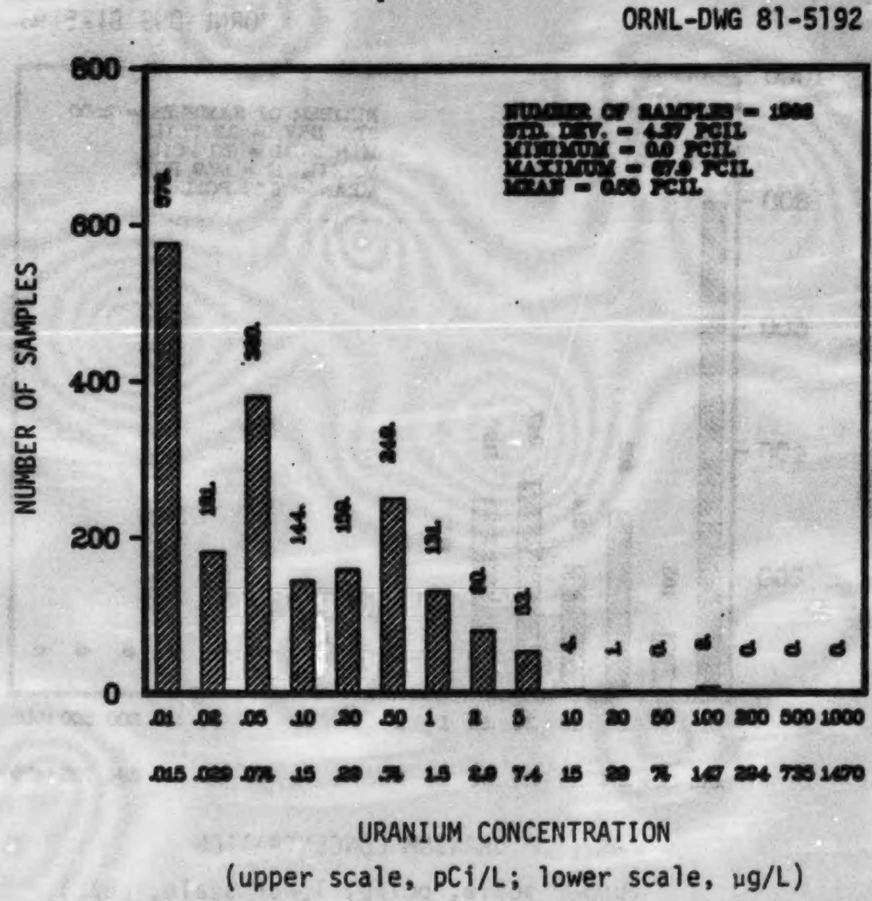


Fig. 3.187. Histogram of uranium concentrations in surface waters of Wisconsin.

### 3.50.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Wisconsin domestic waters was estimated to be 0.2 pCi/L, 15th highest among all states (Appendix 2). The alpha radiation bone dose computed from this average was 3 mrem/year for Model I and <1 mrem/year for Model II.

### 3.50.4 Water Supplies Exceeding Given Concentrations

We estimated that 3% to 9% of Wisconsin water supplies have uranium concentrations in excess of 1 pCi/L; 0% to 2%, in excess of 5 pCi/L; 0% to 0.6%, in excess of 10 pCi/L; and 0% to 0.4%, in excess of 20 pCi/L.

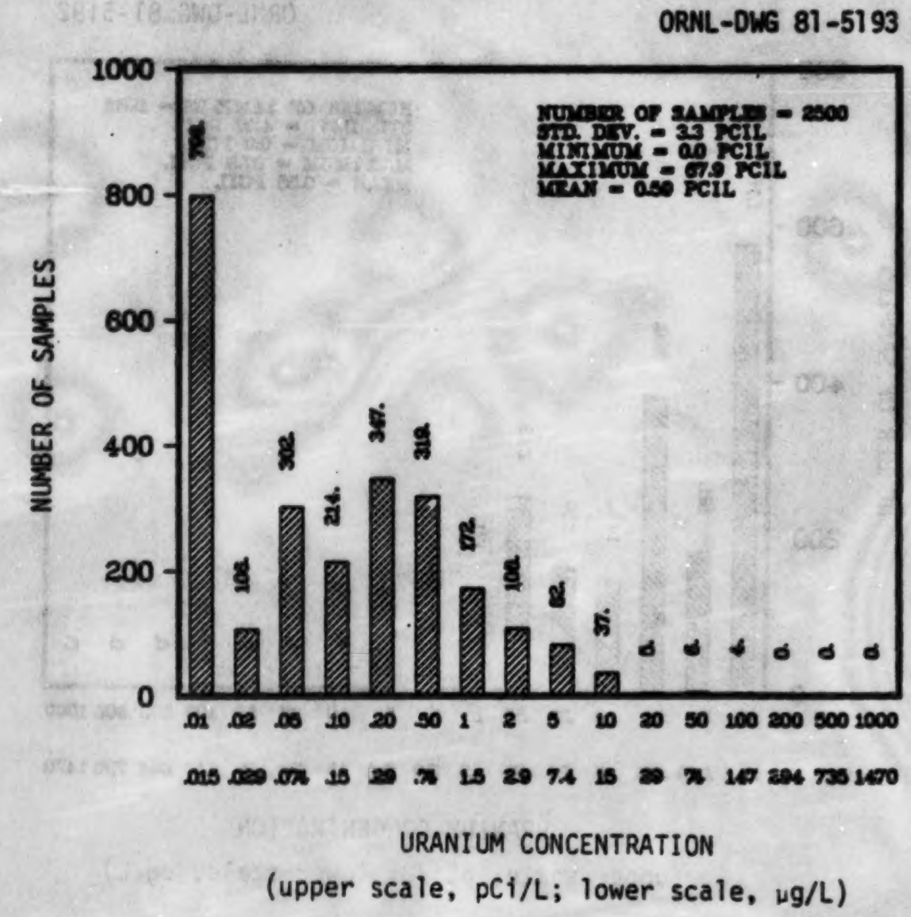


Fig. 3.188. Histogram of uranium concentrations in ground waters of Wisconsin.

## 3.51 URANIUM IN WYOMING WATERS

### 3.51.1 Extent of Coverage

NURE data were available for approximately 54% of Wyoming, chiefly the central, south-central, southeastern, and southwestern sectors [35, 42,53,55,58]. A few additional non-NURE analyses were found for towns randomly distributed over the state [15,17]. In all, 5946 surface and ground water sites were surveyed (Fig. 3.190).

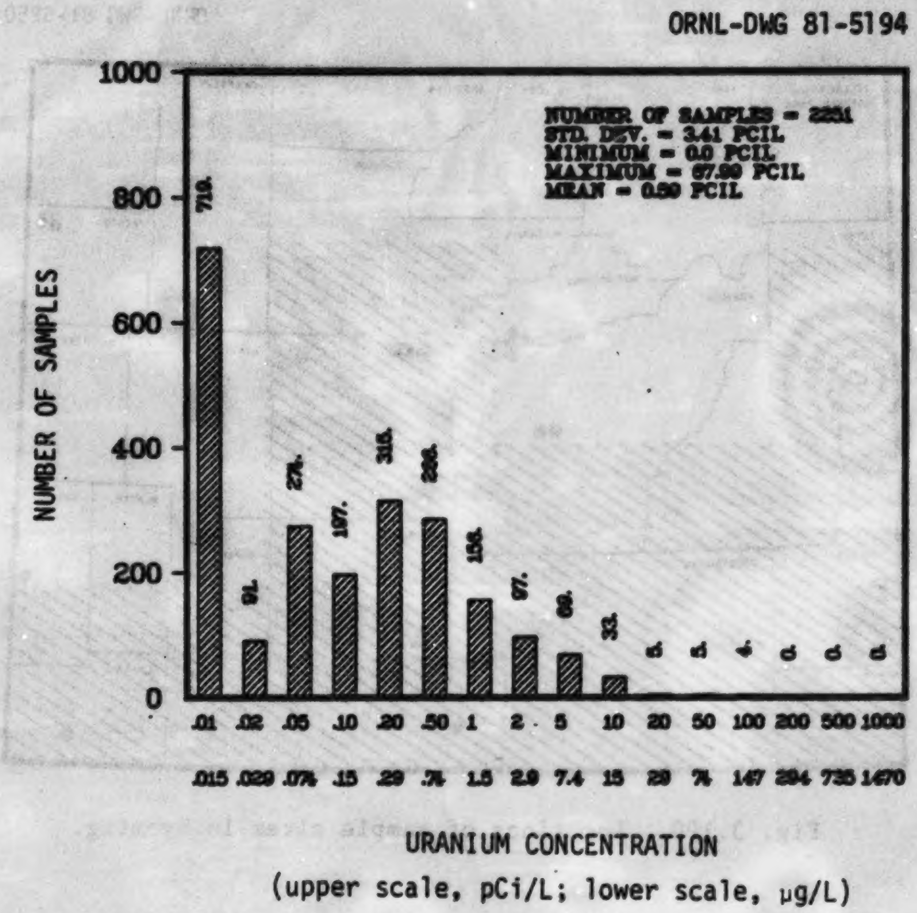


**Fig. 3.189. Histogram of uranium concentrations in domestic waters of Wisconsin.**

### **3.51.2 Concentrations of Uranium in Samples**

**3.51.2.1 Surface Waters — Uranium in 2288 Wyoming surface water samples ranged from 0.01 to 304.78 pCi/L and averaged 2.6 pCi/L. The modal and median concentration ranges in these waters were 0.2 to 0.5 pCi/L and 0.5 to 1 pCi/L, respectively (Fig. 3.191).**

**3.51.2.2 Ground Waters — Thirty-six hundred fifty-eight Wyoming ground water analyses were found. Uranium in the samples ranged from 0.01 to 202.77 pCi/L and averaged 6.25 pCi/L. The median and modal concentration ranges for this subset of samples were identical, 2 to 5 pCi/L (Fig. 3.192).**

ORNL-DWG 81-5250

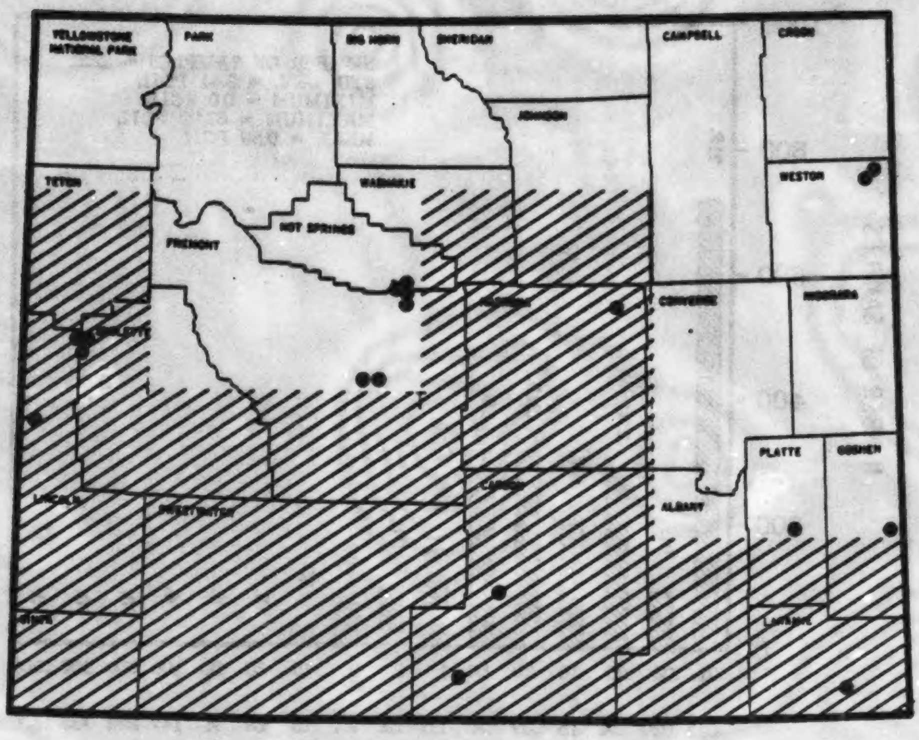

YELLOWSTONE NATIONAL PARK
PARK
BIG HORN
SHERIDAN
CAMPBELL
CROOK
JOHNSON
WESTON
TETON
WASHAKIE
HOT SPRINGS
FREMONT
NATRONA
CONVERSE
NIOBRARA
SUBLETTE
LINCOLN
SWEETWATER
CARBON
ALBANY
PLATTE
GOSHEN
UINTA
LARAMIE

Fig. 3.190. Locations of sample sites in Wyoming.

3.51.2.3 Established Domestic and Municipal Waters — Seventy-four of the listed Wyoming water sites were identified as domestic or municipal sources. Concentrations of uranium in these sources ranged from 0.07 to 67.64 pCi/L and averaged 6.38 pCi/L. The modal and median concentration ranges were identical, 2 to 5 pCi/L (Fig. 3.193).

3.51.2.4 Treated Waters from Municipal Water Purification Plants — It is not known if water from any of the listed Wyoming sources received standard municipal water plant treatments before analysis.

### 3.51.3 Population-Weighted Average Concentration

The population-weighted average concentration of uranium in Wyoming domestic waters was estimated to be 2.7 pCi/L, 4th highest among all states (Appendix 2). The corresponding alpha radiation bone dose was 41 mrem/year for Model I and 2 mrem/year for Model II.

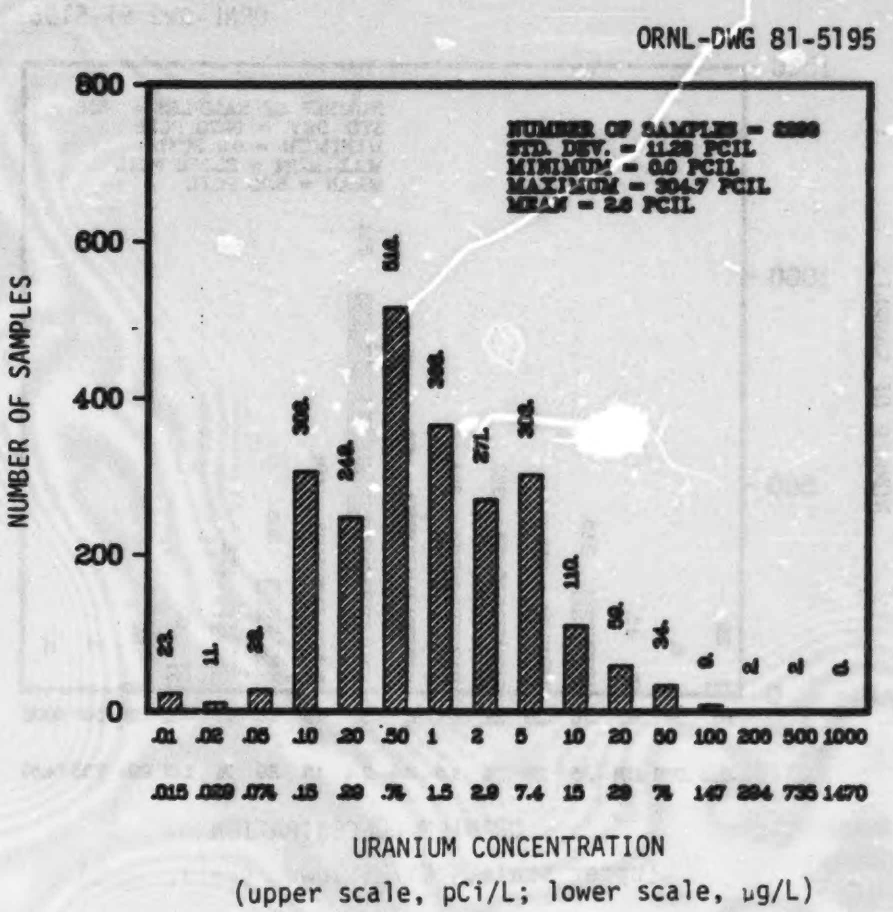


Fig. 3.191. Histogram of uranium concentrations in surface waters of Wyoming.

### 3.51.4 Water supplies Exceeding Given Concentrations

We estimated that 50% to 80% of Wyoming water supplies have uranium concentrations in excess of 1 pCi/L; 0% to 29%, in excess of 5 pCi/L; 0% to 16%, in excess of 10 pCi/L; and 0% to 9%, in excess of 20 pCi/L.

## 3.52 URANIUM IN U.S. WATERS

### 3.52.1 Extent of Coverage

Uranium analyses were available for considerably less than one-half, possibly less than one-third, of the desired sample sites in the

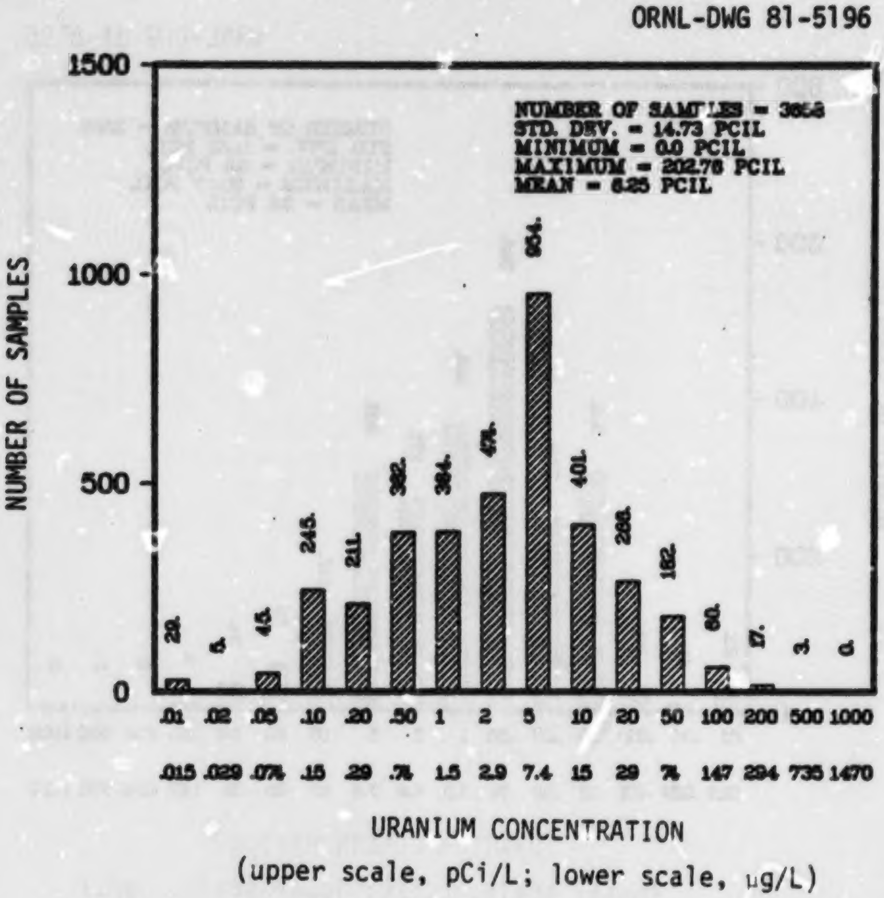


Fig. 3.192. Histogram of uranium concentrations in ground waters of Wyoming.

United States. Overall, data were compiled for some 89 994 sample sites, including the municipal water treatment plants of the nation's 100 largest cities. Despite this incomplete coverage, the consistently low concentrations of uranium reported for most of the listed sites provides considerable assurance that the averages reported here are indeed representative. For example, 17 states had population-weighted averages estimated as less than 0.1 pCi/L and 39 had averages less than 1 pCi/L. There can be little doubt that the average concentrations of uranium in the drinking waters of these states are low. However, the range of concentrations of uranium in the drinking waters of 12 western states is considerably greater than that for states east of the Mississippi River,

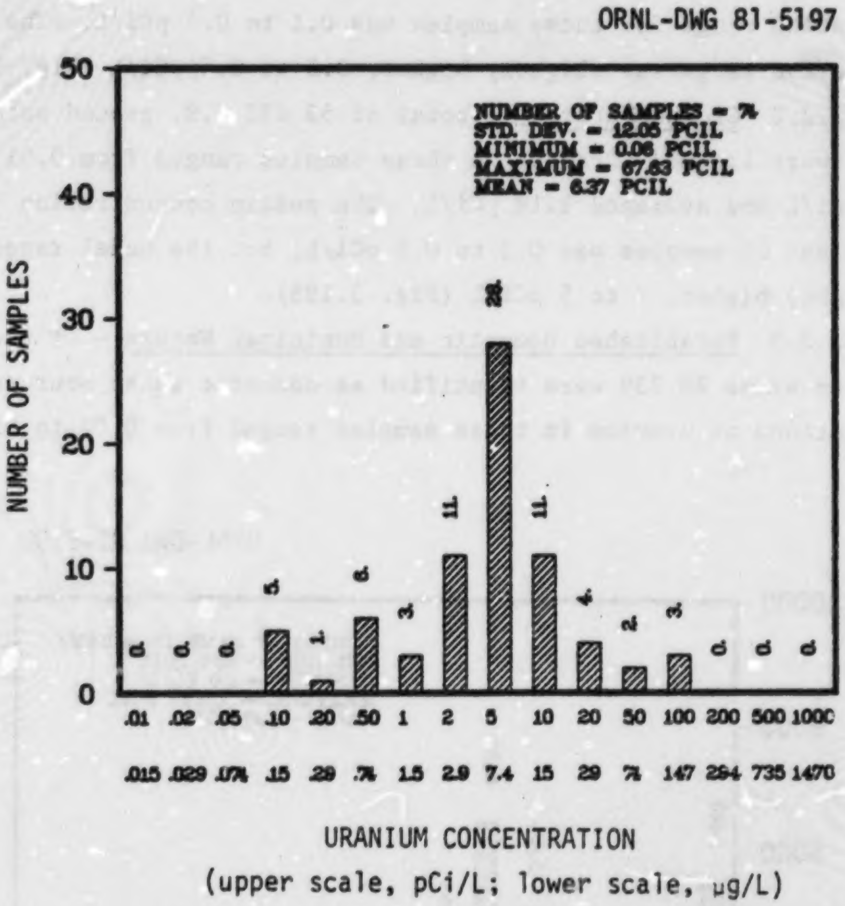


Fig. 3.193. Histogram of uranium concentrations in domestic waters of Wyoming.

and adequate data are not yet available for several of these states, particularly South Dakota, New Mexico, California, Nebraska, Arizona, Montana, and Kansas. Fortunately, extensive analytical data are available for several of the 12 western states with high average concentrations, such as Colorado, Texas, Nevada, and Wyoming.

### 3.52.2 Concentrations of Uranium in Samples

3.52.2.1 Surface Waters — A total of 34 561 U.S. surface water analyses were recorded. The concentrations of uranium in these samples ranged from 0.01 to 582.38 pCi/L and averaged 1.06 pCi/L. The median concentration range for these samples was 0.1 to 0.2 pCi/L. The modal concentration range was slightly higher, 0.2 to 0.5 pCi/L (Fig. 3.194).

3.52.2.2 Gtound Waters — A total of 55 433 U.S. ground water analyses were listed. Uranium in these samples ranged from 0.01 to 652.80 pCi/L and averaged 3.18 pCi/L. The median concentration range for this set of samples was 0.2 to 0.5 pCi/L, but the modal range was considerably higher, 2 to 5 pCi/L (Fig. 3.195).

3.52.2.3 Established Domestic and Municipal Waters — Of the listed U.S. water sites 28 239 were identified as domestic water sources. The concentrations of uranium in these samples ranged from 0.07 to 652.80

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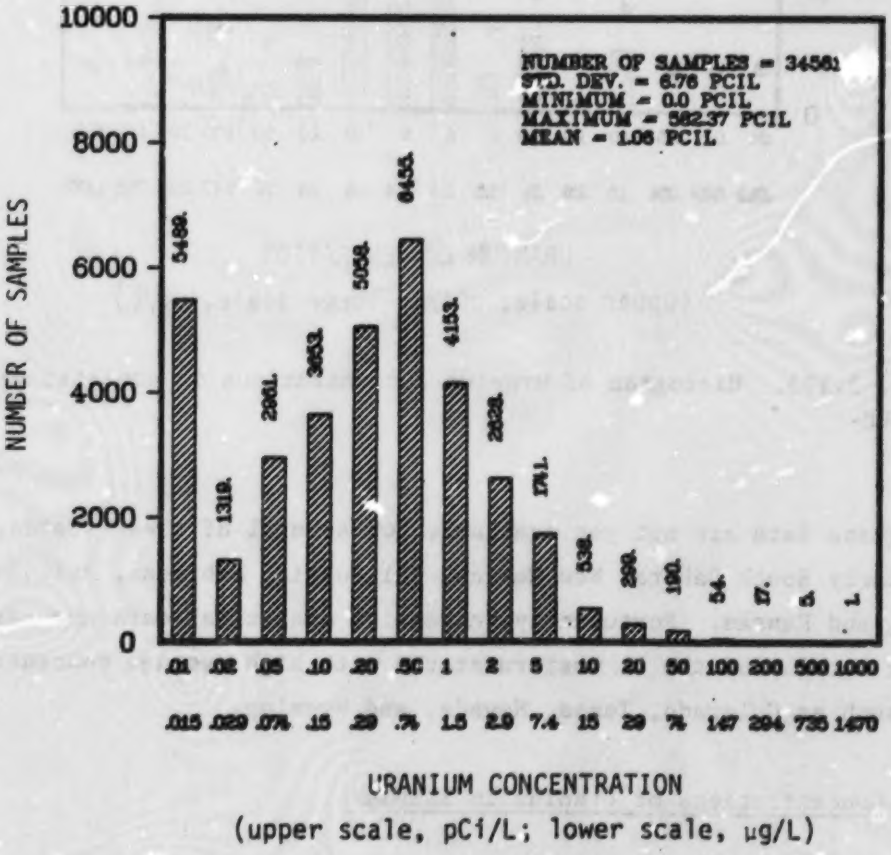

Fig. 3.194. Histogram of uranium concentrations in surface waters of the United States.

ORNL-DWG 81-5199

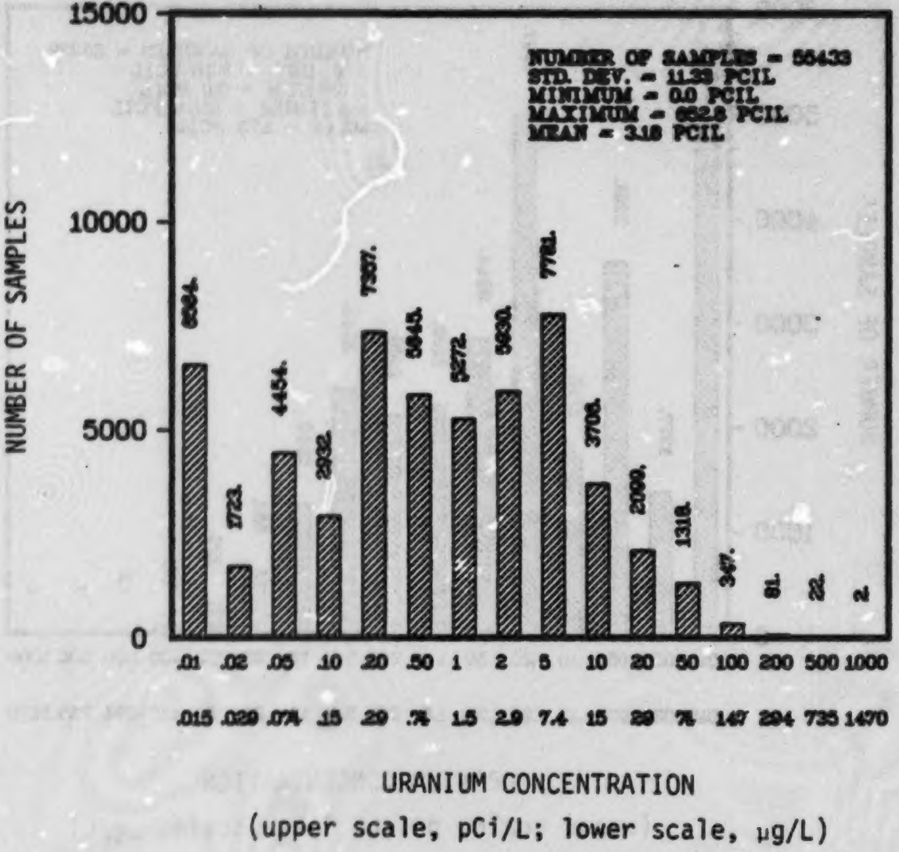

Fig. 3.195. Histogram of uranium concentrations in ground waters of the United States.

pCi/L and averaged 1.73 pCi/L. The median and modal concentration ranges were identical, 0.1 to 0.2 pCi/L (Fig. 3.196).

3.52.2.4 Treated Waters from Municipal Water Purification Plants — See the sections for individual states for a discussion of treated waters from municipal water purification plants.

### 3.52.3 Population-Weighted Average Concentration

An estimate of the population-weighted average concentration of uranium in U.S. domestic waters was computed from the values estimated for each state, weighting each state value with the state's population. In this computation values marked with a "less than" symbol (<) were

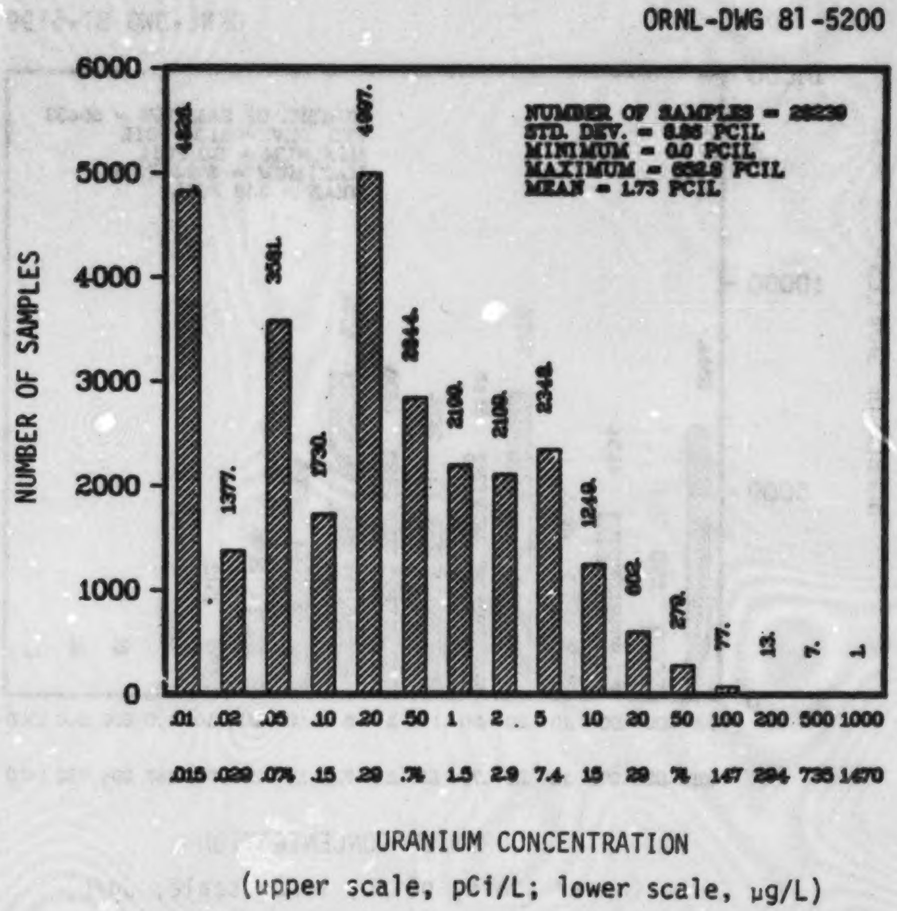

Fig. 3.196. Histogram of uranium concentrations in domestic waters of the United States.

summed as though the "less than" symbol were not present. The resulting population-weighted average concentration of uranium in U.S. drinking water was 0.8 pCi/L. Based on this value, the average U.S. alpha radiation bone dose was estimated to be 12 mrem/year for Model I and <1 mrem/year for Model II.

### 3.52.4 Water Supplies Exceeding Given Concentrations

Using U.S. totals, we estimated that 15% to 24% of all U.S. water supplies have uranium concentrations in excess of 1 pCi/L; 4% to 8%, in excess of 5 pCi/L; 0.1% to 3%, in excess of 10 pCi/L; and 0.04% to 1%, in excess of 20 pCi/L.

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# Appendixes

## APPENDIX 1

## SOURCES CONTACTED AND DATA BASES SEARCHED

### SOURCES CONTACTED

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# APPENDIX 2

## ESTIMATION OF POPULATION-WEIGHTED AVERAGE CONCENTRATIONS OF URANIUM IN THE DOMESTIC WATERS OF THE STATES

The computation of a population-weighted average concentration of uranium in the domestic waters of a given state requires knowledge of the number of water supplies in the state, the population served by each, and the uranium analysis of the water produced by each supply. Although some of these data were available for water supplies in all states — for example, the number of water supplies and the populations served — corresponding uranium analyses were seldom available, and for no state was there sufficient information to generate a firm population-weighted average concentration. It was therefore necessary to estimate this quantity, making best use of available information and using the least number of arbitrary assumptions. The following procedure was used.

The estimates were based on the 768 water supplies listed in the *1970 Statistical Report of the American Water Works Association (AWWA)*. This report indicates the populations served by each supply. Measured uranium concentrations were available for treated waters from about 100 of these water supplies, primarily the largest ones. For the remaining water supplies, uranium concentrations were estimated by averaging analyses from nearby sites having a similar type of water (i.e., ground or surface water). When no assays were available for nearby water sources, the midpoint of the most frequently occurring concentration range in the state's domestic water histogram was used. The basis of each estimated concentration is given in Tables A2.1-A2.51. For those waters consumed by the population of the state not represented by the water supplies listed in the *1970 AWWA Statistical Report*, the uranium concentrations were also taken as equal to the midpoint of the most frequently occurring concentration range in the state's domestic water histogram. Each of the measured or estimated treated water concentrations was weighted with a factor derived from the population served by the water supply and the total population of the state as noted in the 1970 population census. The sum of these weighted factors was taken as the state's population-weighted average concentration.

By and large, the population-weighted average concentrations prepared in the manner described appear consistent and reasonable.

Table A2.1. Alabama (total population 3 444 354[a])

| City or utility | Uranium in treated water (μg/L) Measured | Uranium in treated water (μg/L) Estimated | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| Andalusia | | 0.7[b] | 11 | 0.003 | 0.002 |
| Anniston | 0.53[c] | | 60 | 0.017 | 0.009 |
| Auburn | | 1.5[d] | 23 | 0.007 | 0.011 |
| Birmingham | 0.20[e] | | 525 | 0.152 | 0.030 |
| Florence | | 0.3[f] | 42.275 | 0.012 | 0.004 |
| Huntsville | 0.35[c] | | 160 | 0.046 | 0.016 |
| Mobile | 0.10[e] | | 200 | 0.058 | 0.006 |
| Montgomery | 0.10[e] | | 160 | 0.046 | 0.005 |
| Selma | | 1.1[g] | 26.941 | 0.008 | 0.009 |
| Sheffield | | 0.3[f] | 14 | 0.004 | 0.001 |
| Tuscaloosa | | 0.2[h] | 70 | 0.020 | 0.004 |
| Nonurban | | 0.01[i] | 2152.138 | 0.625 | 0.006 |
| Total | | | | | 0.103 |

Population-weighted average concentration (μg/L) = 0.103
(pCi/L) = 0.070

Estimated per capita bone dose
Model I 0.103 × 10.2 = 1 mrem/year
Model II 0.103 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 1-9

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[a] 1970 Census.

[b] Scott and Barker, 1962.

[c] Average of Camden and Brewton in Scott and Barker, 1962.

[d] Durfor and Becker, 1964.

[e] Equals Tuskegee in Scott and Barker, 1962.

[f] Equals Tuscumbia in Scott and Barker, 1962.

[g] Average of Calhoun, Camden, and Wedgeworth in Scott and Barker, 1962.

[h] Equals Birmingham in Scott and Barker, 1962.

[i] Equals average of most frequently occurring concentration range from domestic water histogram.

Table A2.2. Alaska (total population 302 583[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Anchorage | | 0.5[b] | 60 | 0.198 | 0.099 |
| Anchorage (Central Alaska Utility) | | 0.5[b] | 18 | 0.059 | 0.030 |
| Fairbanks | | 0.1[c] | 10.8 | 0.035 | 0.004 |
| Nonurban | | 0.5[b] | 214.083 | 0.708 | 0.354 |
| Total | | | | | 0.487 |

Population-weighted average concentration (μg/L) = 0.487
(pCi/L) = 0.331

Estimated per capita bone dose
Model I 0.487 × 10.2 = 5 mrem/year
Model II 0.487 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-0.04
5 pCi/L = 0-0.3
1 pCi/L = 0-6

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[a] 1970 Census.

[b] Average of most frequently occurring concentration range in surface water histogram.

[c] Equal to lake water sample A39[illegible]6 at latitude 64.7750, longitude 147.7151 (near Fairbanks in Sharp, Aamodt, and Hill, 1979).

Table A2.3. Arizona (total population 1 775 399[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Flagstaff |  | 0.5[b] | 26.5 | 0.015 | 0.008 |
| Glendale | 0.5[c] |  | 45 | 0.025 | 0.013 |
| Mesa |  | 2.4[d] | 80 | 0.045 | 0.108 |
| Phoenix | 2.4[e] |  | 623 | 0.357 | 0.857 |
| Stafford |  | 0.4[f] | 10.79 | 0.006 | 0.002 |
| Scottsdale |  | 2.4[d] | 20 | 0.011 | 0.026 |
| Sun City Water Company |  | 2.4[d] | 16.5 | 0.009 | 0.022 |
| Tempe |  | 2.4[d] | 70 | 0.039 | 0.094 |
| Tucson | 5.0[e] |  | 299.972 | 0.169 | 0.845 |
| Yuma | 6.9[c] |  | 35.875 | 0.020 | 0.138 |
| Nonurban |  | 5.15[g] | 537.762 | 0.303 | 1.560 |
| Total |  |  |  |  | 3.673 |

Population-weighted average concentration (μg/L) = 3.673
(pCi/L) = 2.498

Estimated per capita bone dose
Model I 3.673 × 10.2 = 37 mrem/year
Model II 3.673 × 0.381 = 1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-8
10 pCi/L = 0-15
5 pCi/L = 0-24
1 pCi/L = 65-70

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[a] 1970 Census.
[b] Equals well six miles south of Flagstaff in Scott and Barker, 1962.
[c] Scott and Barker, 1962.
[d] Equals Phoenix in Durfor and Becker, 1964.
[e] Durfor and Becker, 1964.
[f] Equals Fort Thomas in Scott and Barker, 1962.
[g] Equals average of most frequently occurring concentration range in domestic water histogram.

Table A2.4. Arkansas (total population 1 923 322[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Camden | | 0.1[b] | 18 | 0.009 | 0.001 |
| Conway | | 0.2[c] | 16.8 | 0.009 | 0.002 |
| El Dorado | | 0.7[d] | 27.5 | 0.014 | 0.010 |
| Fayetteville | | 0.1[e] | 30 | 0.016 | 0.002 |
| Hot Springs | | 0.2[c] | 40 | 0.021 | 0.004 |
| Little Rock | | 0.2[c] | 159.728 | 0.083 | 0.017 |
| Magnolia | | 0.7[d] | 12 | 0.006 | 0.004 |
| Texarkana | | 0.7[d] | 50 | 0.026 | 0.018 |
| Nonurban | | 0.1[e] | 1569.294 | 0.816 | 0.082 |
| Total | | | | | 0.140 |

Population-weighted average concentration (µg/L) = 0.140
(pCi/L) = 0.095

Estimated per capita bone dose
Model I 0.140 × 10.2 = 1 mrem/year
Model II 0.140 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.

[b] Equal to average for Murfreesboro and Pine Bluff in Scott and Barker, 1962.

[c] Equal to average for Norman, Murfreesboro, Pine Bluff and well four miles east of Owensville in Scott and Barker, 1962.

[d] Equal to well three miles east of Magnolia in Scott and Barker, 1962.

[e] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.5. California (total population 19 971 069[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Alhambra | | 5.1[b] | 62.125 | 0.003 | 0.015 |
| Antioch | | 5.1[b] | 30 | 0.002 | 0.010 |
| Apple Valley Ranchos Water | | 5.1[b] | 14 | 0.001 | 0.005 |
| Atascadero Mtl. Water Co. | | 5.1[b] | 14 | 0.001 | 0.005 |
| Azusa | | 5.1[b] | 25 | 0.001 | 0.005 |
| Azusa-Azusa Valley Water | | 5.1[b] | 50 | 0.003 | 0.015 |
| Bakersville-Calif. Water Service | | 5.1[b] | 130.6 | 0.007 | 0.036 |
| Bakersville-E. Niles Community | | 5.1[b] | 14.3 | 0.001 | 0.005 |
| Bear Gulch-Calif. Water Service | | 5.1[b] | 55.9 | 0.003 | 0.015 |
| Bellflower Water Co. | | 3.5[c] | 10 | 0.001 | 0.004 |
| Bellflower-Peerless Water | | 3.5[c] | 10 | 0.001 | 0.004 |
| Bellflower-Somerset Water | | 3.5[c] | 13.5 | 0.001 | 0.004 |
| Beverly Hills | | 3.5[c] | 40.4 | 0.002 | 0.007 |
| Buena Hills | | 3.5[c] | 63.7 | 0.003 | 0.011 |
| Burbank | | 3.5[c] | 89 | 0.004 | 0.014 |
| Burlingame | | 5.1[b] | 28.6 | 0.001 | 0.005 |
| Calabasas-Las Virgene Water | | 5.1[b] | 20 | 0.001 | 0.005 |
| Campbell Water Co. | | 5.1[b] | 19.5 | 0.001 | 0.005 |
| Carlsbad | | 6.9[d] | 15.75 | 0.001 | 0.007 |
| Carmichael | | 5.1[b] | 33 | 0.002 | 0.010 |
| Casitas Municipal Water District | | 5.1[b] | 56 | 0.003 | 0.015 |
| Cerritos | | 5.1[b] | 27.2 | 0.001 | 0.005 |
| Chico-Calif. Water Service | | 5.1[b] | 32.8 | 0.002 | 0.010 |
| Citrus Heights Irrigation District | | 5.1[b] | 25 | 0.001 | 0.005 |
| Clovis | | 5.1[b] | 14 | 0.001 | 0.005 |
| Coachella | | 5.1[b] | 20.1 | 0.001 | 0.005 |
| Compton-Park Water Co. | | 3.5[c] | 175 | 0.009 | 0.032 |
| Corte Madera-Marin Municipal | | 5.1[b] | 180 | 0.009 | 0.046 |
| Covina | | 5.1[b] | 20 | 0.001 | 0.005 |
| Cupertino | | 5.1[b] | 10.5 | 0.001 | 0.005 |
| Cutten-Humboldt Community Service | | 5.1[b] | 11 | 0.001 | 0.005 |
| Downey | | 3.5[c] | 50 | 0.003 | 0.011 |
| E. Los Angeles-Calif. Water Service | | 5.1[b] | 83.3 | 0.004 | 0.020 |
| El Monte-Garvey San Gabriel | | 5.1[b] | 184.286 | 0.009 | 0.046 |
| El Segundo | | 3.5[c] | 15.5 | 0.001 | 0.004 |
| Escondido | | 6.9[d] | 39.8 | 0.002 | 0.014 |
| Fairfield | | 5.1[b] | 32 | 0.002 | 0.010 |
| Fallbrook | | 5.1[b] | 12 | 0.001 | 0.005 |
| Fremont-Alameda City Water | | 5.1[b] | 135 | 0.007 | 0.036 |
| Fresno | 0.5[e] | | 180 | 0.009 | 0.005 |
| Fullerton | | 3.5[c] | 86.1 | 0.004 | 0.014 |

Table A2.5 (continued)

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Garden Grove |  | 3.5[c] | 124 | 0.006 | 0.021 |
| Glendale |  | 3.5[c] | 124 | 0.006 | 0.021 |
| Goleta |  | 5.1[b] | 60 | 0.003 | 0.015 |
| Hanford |  | 5.1[b] | 22 | 0.001 | 0.005 |
| Hawthorne |  | 3.5[c] | 27 | 0.001 | 0.004 |
| Hemet-Eastern Municipal District |  | 5.1[b] | 25 | 0.001 | 0.005 |
| Hemet-Lake Hemet Water District |  | 5.1[b] | 16.5 | 0.001 | 0.005 |
| Hermosa Recondo-Calif. Water |  | 3.5[c] | 85.4 | 0.004 | 0.014 |
| Huntington Beach |  | 3.5[c] | 124 | 0.006 | 0.021 |
| Inglewood |  | 3.5[c] | 73.5 | 0.004 | 0.014 |
| Irvine Ranch Water District |  | 5.1[b] | 12.341 | 0.001 | 0.005 |
| La Crescenta |  | 5.1[b] | 35 | 0.002 | 0.010 |
| La Mesa Helix Irrigation |  | 6.9[d] | 163 | 0.008 | 0.055 |
| La Puente Suburan Water District |  | 5.1[b] | 135 | 0.007 | 0.036 |
| Laguna Beach |  | 3.5[c] | 20 | 0.001 | 0.004 |
| Laguna Hills-Rossmoor Co. |  | 5.1[b] | 20.8 | 0.001 | 0.005 |
| Lakewood |  | 3.5[c] | 69 | 0.003 | 0.011 |
| Livermore-Calif. Water Service |  | 5.1[b] | 37.2 | 0.002 | 0.010 |
| Long Beach | 3.5[e] |  | 361 | 0.018 | 0.063 |
| Los Altos-Calif. Water Service |  | 5.1[b] | 56.4 | 0.003 | 0.015 |
| Los Angeles | 4.8[e] |  | 2862 | 0.143 | 0.686 |
| Los Angeles-S. Calif. Water Co. | 4.8[e] |  | 663.7 | 0.033 | 0.158 |
| Lynwood |  | 3.5[c] | 43 | 0.002 | 0.007 |
| Madera |  | 5.1[b] | 16.6 | 0.001 | 0.005 |
| Marysville-Calif. Water Service |  | 5.1[b] | 10 | 0.001 | 0.005 |
| Merced |  | 5.1[b] | 30 | 0.002 | 0.010 |
| Milpitas |  | 5.1[b] | 28.6 | 0.001 | 0.005 |
| Modesto-Del Este Water Co. |  | 5.1[b] | 48 | 0.002 | 0.010 |
| Montebello-Land Water Co. |  | 5.1[b] | 11.5 | 0.001 | 0.005 |
| Monterey Park |  | 5.1[b] | 50 | 0.003 | 0.015 |
| Napa |  | 5.1[b] | 47.4 | 0.002 | 0.010 |
| Navato-N. Martin County |  | 5.1[b] | 30 | 0.002 | 0.010 |
| Oak View-Casitos Water District |  | 5.1[b] | 56 | 0.003 | 0.015 |
| Oakland-E. Bay Municipal Utility | 0.1[e] |  | 1080 | 0.054 | 0.005 |
| Oceanside |  | 6.9[d] | 45.3 | 0.002 | 0.014 |
| Oildale Mutual Water Co. |  | 5.1[b] | 24.5 | 0.001 | 0.005 |
| Oroville-Wyndt Irrigation District |  | 5.1[b] | 18 | 0.001 | 0.005 |
| Oxnard |  | 5.1[b] | 75 | 0.004 | 0.020 |
| Pacifica-N. Coast Water District |  | 5.1[b] | 36 | 0.002 | 0.010 |
| Palm Springs-Desert Water |  | 5.1[b] | 25 | 0.001 | 0.005 |

Table A2.5 (continued)

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Paradise |  | 5.1[b] | 22 | 0.001 | 0.005 |
| Pasadena |  | 3.5[c] | 137.187 | 0.007 | 0.025 |
| Poway |  | 6.9[d] | 15 | 0.001 | 0.007 |
| Rialto-W. San Bernadino |  | 5.1[b] | 15 | 0.001 | 0.005 |
| Riverside |  | 5.1[b] | 122 | 0.006 | 0.030 |
| Riverside-Jurupa Community Service |  | 5.1[b] | 10.344 | 0.001 | 0.005 |
| Rosemead-San Gabriel Co. |  | 5.1[b] | 45 | 0.002 | 0.010 |
| Sacramento | 0.1[e] |  | 270 | 0.014 | 0.001 |
| Sacramento City Water Resources | 0.1[e] |  | 12 | 0.001 | 0.000 |
| Sacramento-Arcade County | 0.1[e] |  | 85 | 0.004 | 0.000 |
| Salina-Calif. Water Service |  | 5.1[b] | 44.4 | 0.002 | 0.010 |
| San Carlos-Calif. Water Service |  | 5.1[b] | 29.2 | 0.001 | 0.005 |
| San Diego | 6.9[e] |  | 723 | 0.036 | 0.248 |
| San Dimas-Calif. Cities Water |  | 3.5[c] | 28.724 | 0.001 | 0.004 |
| San Francisco | 0.3[e] |  | 2000 | 0.100 | 0.030 |
| San Francisco-Calif. Pacific Co. | 0.3[e] |  | 14 | 0.001 | 0.000 |
| San Jose Public Water Dept. | 0.5[e] |  | 15 | 0.001 | 0.001 |
| San Jose Waterworks | 0.5[e] |  | 525 | 0.026 | 0.013 |
| San Mateo-Calif. Water Service |  | 5.1[b] | 73.4 | 0.004 | 0.020 |
| Santa Ana |  | 3.5[c] | 139.9 | 0.007 | 0.025 |
| Santa Barbara |  | 5.1[b] | 70 | 0.004 | 0.020 |
| Santa Clara |  | 5.1[b] | 85.2 | 0.004 | 0.020 |
| Santa Cruz |  | 5.1[b] | 50 | 0.003 | 0.015 |
| Santa Maria |  | 5.1[b] | 36 | 0.002 | 0.010 |
| Santa Maria-Calif. Consolidated |  | 5.1[b] | 20 | 0.001 | 0.005 |
| Santa Monica |  | 3.5[c] | 88.289 | 0.004 | 0.014 |
| Santa Paula |  | 5.1[b] | 20.4 | 0.001 | 0.005 |
| Santee City Water District |  | 5.1[b] | 25 | 0.001 | 0.005 |
| South Gate |  | 5.1[b] | 50 | 0.003 | 0.015 |
| S. Lake Tahoe-Tahoe |  | 5.1[b] | 12 | 0.001 | 0.005 |
| S. San Fran-Calif. Water Service |  | 5.1[b] | 41.2 | 0.002 | 0.010 |
| South Pasadena |  | 5.1[b] | 23.250 | 0.001 | 0.005 |
| Spring-Valley-Otay Water |  | 5.1[b] | 26.250 | 0.001 | 0.005 |
| Stockton-Calif. Water Service |  | 5.1[b] | 132 | 0.007 | 0.036 |
| Sunnyvale |  | 5.1[b] | 97.2 | 0.005 | 0.026 |
| Taft-West Kern County |  | 5.1[b] | 20 | 0.001 | 0.005 |
| Ukiah |  | 5.1[b] | 13.1 | 0.001 | 0.005 |
| Vacaville |  | 5.1[b] | 23.139 | 0.001 | 0.005 |
| Ventura |  | 5.1[b] | 65.307 | 0.003 | 0.015 |
| Visalia-Calif. Water Service |  | 5.1[b] | 33.6 | 0.002 | 0.010 |
| Vista Irrigation District |  | 5.1[b] | 33.3 | 0.002 | 0.010 |

Table A2.5 (continued)

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Walnut Valley Water District | | 3.5[c] | 15 | 0.001 | 0.004 |
| Watsonville | | 5.1[b] | 28.445 | 0.001 | 0.005 |
| Whittier | | 3.5[c] | 37 | 0.002 | 0.007 |
| Whittier-Orchard Dale | | 3.5[c] | 13 | 0.001 | 0.004 |
| Yorba Linda | | 5.1[b] | 21 | 0.001 | 0.005 |
| Others | | 5.1[b] | 5644.529 | 0.283 | 1.443 |
| | | | | | 3.992 |

Population-weighted average concentration (μg/L) = 3.992
(pCi/L) = 2.715

Estimated per capita bone dose
Model I 3.992 × 10.2 = 41 mrem/year
Model II 3.992 × 0.381 = 2 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-8
10 pCi/L = 0-8
5 pCi/L = 0-16
1 pCi/L = 56-93

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[a] 1970 Census.

[b] Equal to average of most frequently occurring concentration range in domestic water histogram.

[c] Equal to Long Beach in Durfor and Becker, 1964.

[d] Equal to San Diego in Durfor and Becker, 1964.

[e] Durfor and Becker, 1964.

Table A2.6. Colorado (total population 2 209 596[a])

| City or utility | Uranium in treated water (µg/L) Measured | Uranium in treated water (µg/L) Estimated | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| Boulder | | 0.1[b] | 70 | 0.032 | 0.003 |
| Canon City | | 0.4[c] | 16.479 | 0.007 | 0.003 |
| Commerce City | | 1.1[d] | 25 | 0.011 | 0.012 |
| Colorado Springs | | 1.1[d] | 150 | 0.068 | 0.075 |
| Colorado Springs-Widefield Homes | | 1.1[d] | 10.5 | 0.005 | 0.006 |
| Denver | 1.1[e] | | 772.794 | 0.350 | 0.385 |
| Denver-Baker Metro Water | | 1.1[d] | 18 | 0.008 | 0.009 |
| Denver-Brancroft Water District | | 1.1[d] | 16.5 | 0.007 | 0.008 |
| Durango | 2.4[f] | | 11.2 | 0.005 | 0.012 |
| Englewood | | 1.1[d] | 35 | 0.016 | 0.018 |
| Grand Junction | | 0.1[g] | 22 | 0.010 | 0.001 |
| Greeley | | 0.4[c] | 50 | 0.023 | 0.009 |
| Longmont | | 0.1[b] | 25 | 0.011 | 0.001 |
| Loveland | | 0.1[b] | 17.5 | 0.008 | 0.001 |
| Thornton | | 1.1[d] | 54 | 0.024 | 0.026 |
| Westminster | | 1.1[d] | 25 | 0.011 | 0.012 |
| Wheat Ridge | | 1.1[d] | 20 | 0.009 | 0.010 |
| Nonurban | | 5.1[h] | 870.623 | 0.394 | 2.009 |
| Total | | | | | 2.600 |

Population-weighted average concentration (µg/L) = 2.600
(pCi/L) = 1.768

Estimated per capita bone dose
Model I 2.600 × 10.2 = 27 mrem/year
Model II 2.600 × 0.381 = 1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-3
5 pCi/L = 0-10
1 pCi/L = 6-46

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[a] 1970 Census.
[b] Equal to Arvada in Scott and Barker, 1962.
[c] Equal to sample at latitude 38.4958°, longitude 106.0750° in Felmlee and Cadigan, 1978.
[d] Equal to Denver in Durfor and Becker, 1964.
[e] Durfor and Becker, 1964.
[f] Felmlee and Cadigan, 1978.
[g] Equal to Grand Junction well in Scott and Barker, 1962.
[h] Equal to midpoint of mode for domestic water histogram.

Table A2.7. Connecticut (total population 3 032 217[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Ansonia |  | 0.2[b] | 19.584 | 0.006 | 0.001 |
| Bridgeport Hydraulic Co. | 0.1[c] |  | 340 | 0.112 | 0.011 |
| Clinton-Conn. Water Co. |  | 0.2[b] | 106.2 | 0.035 | 0.007 |
| Derby-Birmingham Water Co. |  | 0.2[b] | 11.385 | 0.004 | 0.001 |
| Groton |  | 0.2[b] | 30.260 | 0.010 | 0.002 |
| Hartford Metro District | 0.1[c] |  | 393 | 0.130 | 0.013 |
| Manchester |  | 0.6[d] | 28.4 | 0.009 | 0.005 |
| Middletown |  | 0.2[e] | 32.5 | 0.011 | 0.002 |
| New Haven | 0.2[c] |  | 400 | 0.132 | 0.026 |
| Norwich |  | 0.5[f] | 40 | 0.013 | 0.007 |
| Plainville |  | 0.5[g] | 15 | 0.074 | 0.037 |
| Rockville Water and Aqueduct Co. |  | 0.1[h] | 13.458 | 0.004 | 0.000 |
| Southington |  | 0.2[e] | 25 | 0.008 | 0.002 |
| Wallingford |  | 0.2[e] | 30 | 0.010 | 0.002 |
| Waterbury |  | 0.2[e] | 109 | 0.036 | 0.007 |
| Willimantic |  | 0.5[f] | 17 | 0.006 | 0.003 |
| Nonurban |  | 0.51[i] | 1421.430 | 0.469 | 0.239 |
| Total |  |  |  |  | 0.365 |

Population-weighted average concentration (μg/L) = 0.365
(pCi/L) = 0.248

Estimated per capita bone dose
Model I 0.365 × 10.2 = 4 mrem/year
Model II 0.365 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-4
10 pCi/L = 0-2
5 pCi/L = 0-3
1 pCi/L = 0-15

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[a] 1970 Census.

[b] Equal to New Haven in Durfor and Becker, 1964.

[c] Durfor and Becker, 1964.

[d] Equal to well one mile east of Manchester in Scott and Barker, 1962.

[e] Equal to average of Hartford and New Haven in Durfor and Becker, 1964.

[f] Equal to Willimantic well in Scott and Barker, 1962.

[g] Equal to Plainville well in Scott and Barker, 1962.

[h] Equal to Hartford in Durfor and Becker, 1964.

[i] Equal to average of third most frequently occurring concentration range in domestic water histogram. The mode is 0.02-0.05 pCi/L, but the higher concentration was used as a conservative gesture, since the distribution was skewed.

Table A2.8. Delaware (total population 548 104[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Wilmington Suburban Water |  | 0.1[b] | 81 | 0.148 | 0.015 |
| Nonurban |  | 0.5[c] | 467.104 | 0.852 | 0.426 |
| Total |  |  |  |  | 0.441 |

Population-weighted average concentration (μg/L) = 0.441
(pCi/L) = 0.300

**Estimated per capita bone dose**
Model I 0.441 × 10.2 = 4 mrem/year
Model II 0.441 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

---

[a] 1970 Census.
[b] Equal to New Castle in Scott and Barker, 1962.
[c] Equal to the median in domestic water histogram.

Table A2.9. District of Columbia (total population 756 668[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| District of Columbia | 0.1[b] | | 1081 | 1.0 | 0.1 |

Population-weighted average concentration (μg/L) = 0.1
(pCi/L) = 0.07

Estimated per capita bone dose
Model I 0.1 × 10.2 = 1 mrem/year
Model II 0.1 × 0.381 = 0.04 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

---

[a] 1970 Census.
[b] Durfor and Becker, 1964.

Table A2.10. Florida (total population 6 791 418[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Bartow | 0.1[b] | | 14 | 0.002 | 0.000 |
| Bradenton-Manatee City System | | 0.1[c] | 80 | 0.012 | 0.001 |
| Cape Coral-GAC Utilities | | 0.7[d] | 14 | 0.002 | 0.001 |
| Clearwater-Pinellas City | | 0.4[e] | 160 | 0.024 | 0.010 |
| Fort Lauderdale | | 0.2[f] | 139 | 0.020 | 0.004 |
| Jacksonville | 0.1[g] | | 201 | 0.030 | 0.003 |
| Jacksonville Beach | | 0.1[h] | 13.6 | 0.002 | 0.000 |
| Key West-Fla. Keys Aqueduct | | 0.2[i] | 52.5 | 0.008 | 0.002 |
| Lakeland | 0.1[b] | | 75 | 0.011 | 0.001 |
| Leesburg | | 1.8[j] | 14 | 0.002 | 0.004 |
| Miami | 0.2[g] | | 500 | 0.074 | 0.015 |
| Naples | | 0.7[d] | 30.8 | 0.005 | 0.004 |
| Orlando | | 1.8[j] | 177 | 0.026 | 0.047 |
| Pensacola | 0.9[b] | | 140 | 0.021 | 0.019 |
| Pompano Beach | | 0.2[i] | 53 | 0.008 | 0.002 |
| St. Petersburg | 0.1[g] | | 235 | 0.035 | 0.004 |
| Tallahassee | 1.2[b] | | 89.5 | 0.013 | 0.016 |
| Tampa | 0.4[g] | | 290 | 0.043 | 0.017 |
| Titusville | | 1.1[k] | 30 | 0.004 | 0.004 |
| West Palm Beach | | 0.2[i] | 71.5 | 0.011 | 0.002 |
| Nonurban | | 1.1[k] | 4411.518 | 0.650 | 0.715 |
| Total | | | | | 0.871 |

Population-weighted average concentration (μg/L) = 0.871
(pCi/L) = 0.592

Estimated per capita bone dose
Model I 0.871 × 10.2 = 9 mrem/year
Model II 0.871 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0-1
1 pCi/L = 10-13

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[a] 1970 Census.

[b] Scott and Barker, 1962.

[c] Equal to St. Petersburg in Durfor and Becker, 1964.

[d] Equal to average of Immokalee and Arcadia in Scott and Barker, 1962 and U.S. Environmental Protection Agency, 1973.

[e] Equal to Tampa in Durfor and Becker, 1964.

[f] Equal to Miami in Durfor and Becker, 1964.

[g] Durfor and Becker, 1964.

[h] Equal to Jacksonville in Durfor and Becker, 1964.

[i] Equal to Miami in Durfor and Becker, 1964.

[j] Equal to Clermont in U.S. Environmental Protection Agency, 1973.

[k] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.11. Georgia (total population 4 587 930[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Atlanta | 0.1[b] | | 700 | 0.153 | 0.015 |
| Columbus | | 0.1[c] | 145 | 0.032 | 0.003 |
| Conyers | | 0.1[c] | 17 | 0.004 | 0.000 |
| Forest Park | | 0.1[c] | 19.994 | 0.004 | 0.000 |
| LaGrange | | 0.1[c] | 28 | 0.006 | 0.001 |
| Macon | | 0.1[c] | 125 | 0.027 | 0.003 |
| Moultrie | | 0.7[d] | 19.943 | 0.004 | 0.003 |
| Newnan | | 0.1[c] | 10.550 | 0.002 | 0.000 |
| Savannah | 0.1[b] | | 106 | 0.023 | 0.002 |
| Thomasville | | 0.7[d] | 19 | 0.004 | 0.003 |
| Nonurban | | 0.05[e] | 3397.443 | 0.741 | 0.037 |
| Total | | | | | 0.067 |

Population-weighted average concentration (μg/L) = 0.067
(pCi/L) = 0.046

Estimated per capita bone dose
Model I 0.067 × 10.2 = <1 mrem/year
Model II 0.067 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0–0.2
10 pCi/L = 0–0.4
5 pCi/L = 0–0.7
1 pCi/L = 0–3

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[a] 1970 Census.
[b] Durfor and Becker, 1964.
[c] Equal to Atlanta in Durfor and Becker, 1964.
[d] Equal to Edison in Scott and Barker, 1962.
[e] Equal to average of second most frequently occurring concentration range in domestic water histogram.

Table A2.12. Hawaii (total population 769 913[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Hilo | | 0[b] | 60 | 0.078 | 0.008 |
| Honolulu | 0.1[c] | | 535 | 0.695 | 0.070 |
| Kahului | | 0.1[b] | 44 | 0.057 | 0.006 |
| Lihue-Kauai City Water Supply | | 0.1[b] | 26 | 0.034 | 0.003 |
| Nonurban | | 0.1[b] | 104.913 | 0.136 | 0.014 |
| Total | | | | | 0.101 |

Population-weighted average concentration (μg/L) = 0.101
(pCi/L) = 0.069

Estimated per capita bone dose
Model I 0.101 × 10.2 = <1 mrem/year
Model II 0.101 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.
[b] Equal to Honolulu in Durfor and Becker, 1964.
[c] Durfor and Becker, 1964.

**Table A2.13. Idaho (total population 713 015[a])**

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Urban and nonurban | | 1.1[b] | 713.015 | 1.0 | 1.1 |

Population-weighted average concentration (µg/L) = 1.100
(pCi/L) = 0.750

Estimated per capita bone dose
Model I 1.100 × 10.2 = 11 mrem/year
Model II 1.100 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0-3
1 pCi/L = 0-13

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[a] 1970 Census.
[b] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.14. Illinois (total population 11 112 797[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Bloomington | | 0.3[b] | 40.5 | 0.004 | 0.001 |
| Champaign-N. Ill. Water | | 0.5[c] | 109.191 | 0.010 | 0.005 |
| Chicago | 0.1[d] | | 4506 | 0.405 | 0.041 |
| Danville | | 0.5[c] | 55 | 0.005 | 0.002 |
| De Kalb | | 0.8[e] | 35 | 0.003 | 0.003 |
| Dixon | | 0.8[e] | 19.8 | 0.002 | 0.001 |
| Downers Grove | | 0.1[f] | 30.107 | 0.003 | 0.000 |
| E. St. Louis-Cahokia Commonfield | | 0.7[g] | 20 | 0.002 | 0.001 |
| Edwardsville | | 0.7[g] | 12 | 0.001 | 0.001 |
| Freeport | | 0.6[h] | 30 | 0.003 | 0.002 |
| Galesburg | | 0.8[e] | 37 | 0.003 | 0.002 |
| Glenview | | 0.1[f] | 23.450 | 0.002 | 0.000 |
| Jacksonville | | 0.1[i] | 25 | 0.002 | 0.000 |
| Joliet | | 0.7[j] | 85 | 0.008 | 0.005 |
| Kankakee | | 0.7[j] | 45 | 0.004 | 0.003 |
| La Grange | | 0.1[f] | 17.814 | 0.002 | 0.000 |
| Loves Park | | 0.6[k] | 12 | 0.001 | 0.001 |
| Moline | | 0.8[l] | 46.237 | 0.004 | 0.003 |
| Niles | | 0.1[f] | 32 | 0.003 | 0.000 |
| Northbrook | | 0.1[f] | 28 | 0.003 | 0.000 |
| Pekin | | 0.5[m] | 35 | 0.003 | 0.002 |
| Peoria | | 0.5[m] | 163 | 0.015 | 0.008 |
| Peru | | 0.8[e] | 13.633 | 0.001 | 0.001 |
| Pontiac | | 0.7[j] | 11 | 0.001 | 0.001 |
| Quincy | | 0.8[l] | 55 | 0.005 | 0.004 |
| Riverside | | 0.1[f] | 10 | 0.001 | 0.000 |
| Rockford | 0.6[d] | | 140.600 | 0.013 | 0.008 |
| Rock Island | | 0.8[l] | 52 | 0.005 | 0.004 |
| Saint Charles | | 0.8[e] | 13.5 | 0.001 | 0.001 |
| Schiller Park | | 0.1[f] | 12.712 | 0.001 | 0.000 |
| Springfield | | 0.1[n] | 125 | 0.011 | 0.001 |
| Sterling-N. Ill. Water | | 0.8[e] | 18 | 0.002 | 0.002 |
| Streator-N. Ill. Water | | 0.7[j] | 24 | 0.002 | 0.001 |
| Winnetka | | 0.1[f] | 14.337 | 0.001 | 0.000 |
| Worth | | 0.1[f] | 12 | 0.001 | 0.000 |
| Others | | 0.5[o] | 9061.710 | 0.815 | 0.408 |
| Total | | | | | 0.512 |

Population-weighted average concentration (µg/L) = 0.512
(pCi/L) = 0.348

Estimated per capita bone dose
Model I 0.512 × 10.2 = 5 mrem/year
Model II 0.512 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.

[b] Equal to average of Greenview and Paxton in Scott and Barker, 1962.

[c] Equal to Paxton in Scott and Barker, 1962.

[d] Durfor and Becker, 1964

[e] Equal to Bureau in Scott and Barker, 1962.

[f] Equal to Chicago in Durfor and Becker, 1964.

[g] Equal to St. Louis in Durfor and Becker, 1964.

[h] Equal to Rockford in Durfor and Becker, 1964.

[i] Equal to average of Pittsfield and Greenview in Scott and Barker, 1962.

[j] Equal to average of Bureau and Paxton in Scott and Barker, 1962.

[k] Equal to Rockford in Durfor and Becker, 1964.

[l] Equal to St. Louis in Durfor and Becker, 1964.

[m] Equal to average of Greenview and Bureau in Scott and Barker, 1962.

[n] Equal to Greenview in Scott and Barker, 1962.

[o] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.15. Indiana (total population 5 195 610[a])

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| City or utility | Uranium in treated water (μg/L) Measured | Uranium in treated water (μg/L) Estimated | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| Bedford | | 0.3[b] | 15 | 0.003 | 0.001 |
| Connersville | | 0.3[b] | 18 | 0.003 | 0.001 |
| Elkhart | | 0.2[c] | 42 | 0.008 | 0.002 |
| Evansville | 0.1[d] | | 132.5 | 0.026 | 0.003 |
| Fort Wayne | 0.1[d] | | 194.669 | 0.037 | 0.004 |
| Frankfort | | 1.1[e] | 14.9 | 0.003 | 0.003 |
| Gary Hobart Water | 0.3[d] | | 250 | 0.048 | 0.014 |
| Greenwood-Indiana Cities | | 1.3[f] | 175 | 0.034 | 0.044 |
| Griffith | | 0.3[g] | 18.018 | 0.003 | 0.001 |
| Hammond | | 0.3[g] | 112 | 0.022 | 0.007 |
| Highland | | 0.3[g] | 25 | 0.005 | 0.002 |
| Hoosier Water-Indianapolis | | 1.3[f] | 25 | 0.005 | 0.007 |
| Indianapolis | 1.3[d] | | 680 | 0.131 | 0.170 |
| Jasper | 0.6[h] | | 10 | 0.002 | 0.001 |
| Logansport | | 1.1[i] | 19.9 | 0.004 | 0.004 |
| Michigan City | | 0.3[g] | 41 | 0.008 | 0.002 |
| Mishawka | | 0.2[j] | 36 | 0.007 | 0.001 |
| Munster | | 0.3[g] | 17 | 0.003 | 0.001 |
| Seymour | | 0.3[b] | 12 | 0.002 | 0.001 |
| South Bend | 0.2[d] | | 140 | 0.027 | 0.005 |
| Valpariso | | 0.3[g] | 20 | 0.004 | 0.001 |
| Vincinnes | | 0.4[k] | 20 | 0.004 | 0.002 |
| West Lafayette | | 1.1[i] | 25 | 0.005 | 0.006 |
| Others | | 1.1[l] | 3152.623 | 0.607 | 0.668 |
| Total | | | | | 0.951 |

Population-weighted average concentration (μg/L) = 0.951
(pCi/L) = 0.647

Estimated per capita bone dose
Model I 0.951 × 10.2 = 10 mrem/year
Model II 0.951 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.
[b] Equal to Columbus in Scott and Barker, 1962.
[c] Equal to South Bend in Durfor and Becker, 1964.
[d] Durfor and Becker, 1964.
[e] Equal to Lafayette in Scott and Barker, 1962.
[f] Equal to Indianapolis in Durfor and Becker, 1964.
[g] Equal to Gary Hobart Water in Durfor and Becker, 1964.
[h] Scott and Barker, 1962.
[i] Equal to Lafayette in Scott and Barker, 1962.
[j] Equal to South Bend in Durfor and Becker, 1964.
[k] Equal to North Terre Haute in Scott and Barker, 1962.
[l] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.16. Iowa (total population 2 825 368[a])

| City or utility | Uranium in treated water (µg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Ames |  | 0.6[b] | 27 | 0.010 | 0.00[illegible] |
| Boone |  | 0.6[b] | 12.645 | 0.004 | 0.002 |
| Cedar Falls |  | 0.7[c] | 29.750 | 0.011 | 0.008 |
| Cedar Rapids |  | 0.2[d] | 110.642 | 0.039 | 0.008 |
| Clinton Water Co. |  | 0.3[e] | 34.7 | 0.012 | 0.004 |
| Council Bluffs |  | 1.9[f] | 62 | 0.022 | 0.042 |
| Davenport |  | 0.3[e] | 135 | 0.048 | 0.014 |
| Des Moines | 1.90[g] |  | 243.773 | 0.086 | 0.163 |
| Dubuque |  | 0.3[e] | 64 | 0.023 | 0.007 |
| Fort Dodge |  | 0.3[h] | 32 | 0.011 | 0.003 |
| Fort Madison |  | 0.3[e] | 15 | 0.005 | 0.002 |
| Iowa City |  | 0.2[i] | 45 | 0.016 | 0.003 |
| Marion |  | 0.2[d] | 18 | 0.006 | 0.001 |
| Marshalltown |  | 1.3[j] | 25 | 0.009 | 0.012 |
| Newton |  | 1.9[f] | 17 | 0.006 | 0.011 |
| Ottumwa |  | 0.1[k] | 29.84 | 0.011 | 0.001 |
| Sioux City |  | 1.9[f] | 86 | 0.030 | 0.057 |
| Spencer |  | 0.3[h] | 10.287 | 0.004 | 0.001 |
| West Des Moines |  | 1.9[f] | 16.441 | 0.006 | 0.011 |
| Nonurban |  | 0.5[l] | 1811.290 | 0.641 | 0.321 |
| Total |  |  |  |  | 0.677 |

Population-weighted average concentration (µg/L) = 0.677
(pCi/L) = 0.460

Estimated per capita bone dose
Model I 0.677 × 10.2 = 7 mrem/year
Model II 0.677 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 26–29

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[a] 1970 Census.
[b] Scott and Barker, 1962.
[c] Equal to average of Edgewood and Ferguson in Scott and Barker, 1962.
[d] Equal to average of Edgewood, Clinton, and Malcolm in Scott and Barker, 1962.
[e] Equal to industrial well in Clinton, Scott, and Barker, 1962.
[f] Equal to Des Moines in Scott and Barker, 1962.
[g] Scott and Barker, 1962.
[h] Equal to Manson in Scott and Barker, 1962.
[i] Equal to average of Clinton and Malcolm in Scott and Barker, 1962.
[j] Equal to Ferguson in Scott and Barker, 1962.
[k] Equal to Glasgow in Scott and Barker, 1962.
[l] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.17. Kansas (total population 2 249 071[a])

| City or utility | Uranium in treated water (µg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Arkansas City | 1.0[b] |  | 17.861 | 0.008 | 0.008 |
| Chanute |  | 0.5[c] | 15.225 | 0.007 | 0.004 |
| Coffeyville |  | 0.5[c] | 17.500 | 0.008 | 0.004 |
| Emporia |  | 4.5[d] | 25 | 0.011 | 0.050 |
| Great Bend-Western P&G |  | 3.7[e] | 17 | 0.008 | 0.030 |
| Hutchinson |  | 3.7[e] | 41.340 | 0.018 | 0.067 |
| Independence |  | 0.5[c] | 13.75 | 0.006 | 0.003 |
| Junction City |  | 0.1[f] | 19.018 | 0.008 | 0.001 |
| Kansas City | 2.40[g] |  | 180 | 0.080 | 0.192 |
| Lawrence |  | 0.1[f] | 46 | 0.020 | 0.002 |
| Leavenworth |  | 2.4[h] | 28 | 0.012 | 0.029 |
| Manhattan |  | 0.1[f] | 25 | 0.011 | 0.001 |
| Mission-Johnson County |  | 2.4[h] | 167.9 | 0.075 | 0.180 |
| Newton |  | 1.2[i] | 17 | 0.008 | 0.010 |
| Ottawa |  | 4.5[j] | 13.888 | 0.006 | 0.027 |
| Parsons |  | 0.5[c] | 15 | 0.007 | 0.004 |
| Pittsburg |  | 0.5[c] | 25 | 0.011 | 0.006 |
| Salina |  | 1.4[k] | 37.714 | 0.017 | 0.024 |
| Topeka | 0.10[g] |  | 133 | 0.059 | 0.006 |
| Wichita | 0.50[g] |  | 284.716 | 0.127 | 0.064 |
| Nonurban |  | 2.2[l] | 1109.159 | 0.493 | 1.085 |
| Total |  |  |  |  | 1.797 |

Population-weighted average concentration (µg/L) = 1.797
(pCi/L) = 1.222

Estimated per capita bone dose
Model I $1.797 \times 10.2 = 18$ mrem/year
Model II $1.797 \times 0.381 = <1$ mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-2
10 pCi/L = 0-5
5 pCi/L = 0-12
1 pCi/L = 40-60

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[a] 1970 Census.

[b] Reference 114 (Wichita NTMS Quadrangle).

[c] Equal to Girard in Scott and Barker, 1962.

[d] Equal to municipal well in Allen, Scott and Barker, 1962.

[e] Equal to Bushton in Scott and Barker, 1962.

[f] Equal to Topeka in Durfor and Becker, 1964.

[g] Durfor and Becker, 1964.

[h] Equal to Kansas City in Durfor and Becker, 1964.

[i] Equal to well field 15 miles north of Wichita in Scott and Barker, 1962.

[j] Equal to Allen in Scott and Barker, 1962.

[k] Equal to Hope in Scott and Barker, 1962.

[l] Equal to average of most frequently occurring concentration range in domestic water histogram.

### Table A2.18. Kentucky (total population 3 220 711[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Frankfort | | 0.1[b] | 34.481 | 0.011 | 0.001 |
| Ft. Mitchell-Kenton City | | 0.1[c] | 52 | 0.016 | 0.002 |
| Hopkinsville | | 2.1[d] | 28.4 | 0.009 | 0.019 |
| Louisville | 0.4[e] | | 673 | 0.209 | 0.084 |
| Paducah | 0.4[f] | | 45 | 0.014 | 0.006 |
| Nonurban | | 0.1[g] | 2387.830 | 0.741 | 0.074 |
| Total | | | | | 0.186 |

Population-weighted average concentration (μg/L) = 0.186
(pCi/L) = 0.126

Estimated per capita bone dose
Model I 0.186 × 10.2 = 2 mrem/year
Model II 0.186 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 20

---

[a] 1970 Census.

[b] Equal to Versailles in Scott and Barker, 1962.

[c] Equal to Cincinnati in Durfor and Becker, 1964.

[d] Equal to Dawson Springs in Scott and Barker, 1962.

[e] Durfor and Becker, 1964.

[f] Equal to Louisville in Durfor and Becker, 1964.

[g] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.19. Louisiana (total population 3 644 637[a])

| City or utility | Uranium in treated water (µg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Alexandria-Central Louisiana Electric | 0.1[b] |  | 80 | 0.022 | 0.002 |
| Baton Rouge | 0.1[c] |  | 183 | 0.050 | 0.005 |
| Lake Charles |  | 0.1[d] | 95 | 0.026 | 0.003 |
| New Orleans | 0.15[c] |  | 569 | 0.156 | 0.023 |
| Ruston | 0.1[b] |  | 19.296 | 0.005 | 0.001 |
| Shreveport | 0.1[c] |  | 200 | 0.055 | 0.006 |
| Nonurban |  | 0.1[e] | 2498.341 | 0.685 | 0.069 |
| Total |  |  |  |  | 0.109 |

Population-weighted average concentration (µg/L) = 0.109
(pCi/L) = 0.074

Estimated per capita bone dose
Model I 0.109 × 10.2 = 1 mrem/year
Model II 0.109 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.
[b] Scott and Barker, 1962.
[c] Durfor and Becker, 1964.
[d] Equal to Alexandria in Scott and Barker, 1962.
[e] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.20. Maine (total population 993 722[a])

| City or utility | Uranium in treated water (μg/L) Measured | Uranium in treated water (μg/L) Estimated | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| Auburn | | 1.3[b] | 20 | 0.020 | 0.026 |
| Augusta | 0.8[c] | | 22 | 0.022 | 0.018 |
| Biddeford-Saco Water Co. | | 0.59[d] | 40 | 0.040 | 0.024 |
| Brewer | | 0.8[e] | 10 | 0.010 | 0.008 |
| Kittery | 0.74[f] | | 15 | 0.015 | 0.011 |
| Portland | 0.59[d] | | 146.480 | 0.147 | 0.087 |
| Rockland and Camden | | 0.59[d] | 21 | 0.021 | 0.012 |
| Nonurban | | 0.2[g] | 719.242 | 0.724 | 0.145 |
| Total | | | | | 0.331 |

Population-weighted average concentration (μg/L) = 0.331
(pCi/L) = 0.225

Estimated per capita bone dose
Model I 0.331 × 10.2 = 3 mrem/year
Model II 0.331 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-4
10 pCi/L = 0-4
5 pCi/L = 0-7
1 pCi/L = 0-13

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[a] 1970 Census.

[b] Equal to sample from latitude 44.2311 and longitude 70.4555 in Prescott, 1980.

[c] Scott and Barker, 1964.

[d] Equal to sample from latitude 43.7578 and longitude 70.3119 in Prescott, 1980.

[e] Equal to sample from latitude 44.3400 and longitude 69.8094 in Prescott, 1980.

[f] Equal to sample from latitude 43.4772 and longitude 70.5597 in Prescott, 1980.

[g] Equal to average of the second most frequently occurring range in domestic water histogram, a more conservative estimate than the mode. The mode is 0.02-0.05 pCi/L.

Table A2.21. Maryland (total population 3 923 897[a])

| City or utility | Uranium in treated water (µg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Baltimore | 0.1[b] |  | 1500 | 0.382 | 0.038 |
| Cambridge |  | 0.1[c] | 16 | 0.004 | 0.000 |
| Cumberland |  | 0.1[d] | 40 | 0.010 | 0.001 |
| Frederick |  | 1.0[e] | 28 | 0.007 | 0.007 |
| Hagerstown |  | 0.1[d] | 70 | 0.018 | 0.002 |
| Havre de Grace |  | 0.1[f] | 10 | 0.003 | 0.000 |
| Hyattsville-Wash. Suburban |  | 0.1[g] | 1200 | 0.306 | 0.031 |
| Joppatowne |  | 0.1[f] | 10 | 0.003 | 0.000 |
| La Vale |  | 0.1[d] | 10 | 0.003 | 0.000 |
| Rockville |  | 0.1[g] | 37 | 0.009 | 0.001 |
| Nonurban |  | 0.1[h] | 1002.897 | 0.256 | 0.026 |
| Total |  |  |  |  | 0.106 |

Population-weighted average concentration (µg/L) = 0.106
(pCi/L) = 0.072

Estimated per capita bone dose
Model I 0.106 × 10.2 = 1 mrem/year
Model II 0.106 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

---

[a] 1970 Census.
[b] Durfor and Becker, 1964.
[c] Equal to Easton in Scott and Barker, 1962.
[d] Equal to Hancock in Scott and Barker, 1962.
[e] Equal to Woodsboro in Scott and Barker, 1962.
[f] Equal to Baltimore in Durfor and Becker, 1964.
[g] Equal to District of Columbia in Durfor and Becker, 1964.
[h] Equal to midpoint of the mode in the domestic water histogram.

Table A2.22. Massachusetts (total population 5 689 170[a])

| City or utility | Uranium in treated water (µg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Adams |  | 0.05[b] | 11.5 | 0.002 | 0.000 |
| Amherst |  | 0.1[c] | 20 | 0.004 | 0.000 |
| Athol |  | 0.05[b] | 11.185 | 0.002 | 0.000 |
| Boston | 0.1[d] |  | 608 | 0.107 | 0.011 |
| Canton |  | 0.1[e] | 18 | 0.003 | 0.000 |
| Fitchburg |  | 0.1[f] | 43.343 | 0.008 | 0.001 |
| Holliston |  | 0.1[g] | 12.5 | 0.002 | 0.000 |
| Holyoke |  | 0.1[c] | 52 | 0.009 | 0.001 |
| Reading |  | 0.1[e] | 22.534 | 0.004 | 0.000 |
| Sommerset |  | 0.1[h] | 18.044 | 0.003 | 0.000 |
| Springfield | 0.1[d] |  | 200 | 0.035 | 0.004 |
| Wayland |  | 0.1[e] | 14 | 0.003 | 0.000 |
| Wellesley |  | 0.1[e] | 28.051 | 0.005 | 0.001 |
| Wilmington |  | 0.1[e] | 18 | 0.003 | 0.000 |
| Worcester | 0.1[d] |  | 172 | 0.030 | 0.003 |
| Nonurban |  | 0.05[b] | 4440.013 | 0.780 | 0.039 |
| Total |  |  |  |  | 0.060 |

Population-weighted average concentration (µg/L) = 0.060
(pCi/L) = 0.041

Estimated per capita bone dose
Model I 0.060 × 10.2 = <1 mrem/year
Model II 0.060 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-0.3
5 pCi/L = 0-0.6
1 pCi/L = 0-8

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[a] 1970 Census.

[b] Equal to average of second most frequently occurring concentration range in domestic water histogram.

[c] Equal to Springfield in Durfor and Becker, 1964.

[d] Durfor and Becker, 1964.

[e] Equal to Boston in Durfor and Becker, 1964.

[f] Equal to Worcester in Durfor and Becker, 1964.

[g] Equal to average of Worcester and Boston in Durfor and Becker, 1964.

[h] Equal to Taunton in Scott and Barker, 1962.

Table A2.23. Michigan (total population 8 881 826[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Ann Arbor |  | 0.6[b] | 99.797 | 0.011 | 0.007 |
| Bay City |  | 0.6[c] | 75 | 0.008 | 0.005 |
| Benton Harbor |  | 0.1[d] | 40 | 0.005 | 0.001 |
| Coldwater |  | 0.9[e] | 10 | 0.001 | 0.001 |
| Dearborn |  | 0.1[f] | 115 | 0.013 | 0.001 |
| Detroit | 0.1[g] |  | 3790.5 | 0.427 | 0.043 |
| Escanaba |  | 0.1[d] | 15.32 | 0.002 | 0.000 |
| Flint | 0.1[g] |  | 193.317 | 0.022 | 0.002 |
| Grand Haven |  | 0.1[d] | 12 | 0.001 | 0.000 |
| Grand Rapids | 0.2[g] |  | 184 | 0.021 | 0.004 |
| Grosse Pointe Farms |  | 0.1[f] | 20 | 0.002 | 0.000 |
| Holland |  | 0.1[d] | 24.411 | 0.003 | 0.000 |
| Iron Mountain |  | 1.2[h] | 15 | 0.002 | 0.002 |
| Jackson |  | 0.9[i] | 49.784 | 0.006 | 0.005 |
| Kalamazoo |  | 0.2[j] | 117.5 | 0.013 | 0.003 |
| Lansing | 0.9[k] |  | 146.36 | 0.016 | 0.014 |
| Monroe |  | 0.1[f] | 30 | 0.003 | 0.000 |
| Muskegon |  | 0.2[j] | 58 | 0.007 | 0.001 |
| Orchard Lake- W. Bloomfield |  | 0.1[f] | 10 | 0.001 | 0.000 |
| Pontiac |  | 0.6[l] | 85 | 0.010 | 0.006 |
| Port Huron |  | 0.1[f] | 40 | 0.005 | 0.001 |
| Roseville |  | 0.1[f] | 60.5 | 0.007 | 0.001 |
| Royal Oak |  | 0.1[f] | 86.238 | 0.010 | 0.001 |
| Saginaw |  | 0.3[m] | 92.567 | 0.010 | 0.003 |
| St. Joseph |  | 0.1[d] | 11.042 | 0.001 | 0.000 |
| Troy |  | 0.1[f] | 30 | 0.003 | 0.000 |
| Warren |  | 0.1[f] | 179 | 0.020 | 0.002 |
| Ypsilanti |  | 0.6[b] | 35 | 0.004 | 0.002 |
| Nonurban |  | 0.51[n] | 3633.807 | 0.409 | 0.209 |
| Total |  |  |  |  | 0.314 |

Population-weighted average concentration (μg/L) = 0.314
(pCi/L) = 0.214

Estimated per capita bone dose
Model I 0.314 × 10.2 = 3 mrem/year
Model II 0.314 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-5
10 pCi/L = 0-5
5 pCi/L = 0-8
1 pCi/L = 0-28

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[a] 1970 Census.
[b] Equal to Pontiac in Scott and Barker, 1962.
[c] Equal to Towas City in Scott and Barker, 1962.
[d] Equal to Chicago in Durfor and Becker, 1964.
[e] Equal to Lansing in Scott and Barker, 1962.
[f] Equal to Detroit in Durfor and Becker, 1964.
[g] Durfor and Becker, 1964.
[h] Equal to Negaunee in Scott and Barker, 1962.
[i] Equal to Lansing in Scott and Barker, 1962.
[j] Equal to Grand Rapids in Scott and Barker, 1962.
[k] Scott and Barker, 1962.
[l] Equal to domestic well in Pontiac, Scott, and Barker, 1962.
[m] Equal to Breckenridge in Scott and Barker, 1962.
[n] Equal to mode midpoint in domestic water histogram.

Table A2.24. Minnesota (total population 3 806 103[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Anoka | | 0.1[b] | 14.347 | 0.004 | 0.000 |
| Austin | | 1.6[c] | 25 | 0.007 | 0.011 |
| Brooklyn Center | | 0.1[d] | 30 | 0.008 | 0.001 |
| Brooklyn Park | | 0.1[d] | 19.5 | 0.005 | 0.001 |
| Cloquet | | 0.2[e] | 32 | 0.008 | 0.002 |
| Duluth | | 0.2[e] | 100 | 0.026 | 0.005 |
| Edina | | 0.1[d] | 35 | 0.009 | 0.001 |
| Fergus Falls | | 0.2[e] | 12.443 | 0.003 | 0.001 |
| Hibbing | | 0.2[e] | 21 | 0.006 | 0.001 |
| Minneapolis | 0.1[f] | | 434.4 | 0.114 | 0.011 |
| Moorhead | | 0.2[e] | 29.687 | 0.008 | 0.002 |
| Owatonna | | 1.6[c] | 15 | 0.004 | 0.006 |
| Red Wing | | 0.1[g] | 10.528 | 0.003 | 0.000 |
| Richfield | | 0.1[d] | 44 | 0.012 | 0.001 |
| Rochester | 1.6[h] | | 54 | 0.014 | 0.022 |
| Roseville | | 0.1[g] | 30 | 0.008 | 0.001 |
| So. St. Paul | | 0.1[g] | 25 | 0.007 | 0.001 |
| St. Louis Park | | 0.1[d] | 48 | 0.013 | 0.001 |
| St. Paul | 0.1[f] | | 404.38 | 0.106 | 0.011 |
| Virginia | | 0.2[e] | 13.4 | 0.004 | 0.001 |
| Willmar | | 0.7[i] | 12.8 | 0.003 | 0.002 |
| Winona | | 0.1[g] | 26.435 | 0.007 | 0.001 |
| Nonurban | | 0.22[j] | 2369.183 | 0.622 | 0.137 |
| Total | | | | | 0.220 |

Population-weighted average concentration (μg/L) = 0.220
(pCi/L) = 0.150

Estimated per capita bone dose
Model I 0.220 × 10.2 = 2 mrem/year
Model II 0.220 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-1
10 pCi/L = 0-4
5 pCi/L = 0-9
1 pCi/L = 14-29

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[a] 1970 Census.
[b] Equal to Wayzata in Scott and Barker, 1962.
[c] Equal to Rochester in Scott and Barker, 1962.
[d] Equal to Minneapolis in Durfor and Becker, 1964.
[e] Equal to Grand Rapids in Scott and Barker, 1962.
[f] Durfor and Becker, 1964.
[g] Equal to St. Paul in Durfor and Becker, 1964.
[h] Scott and Barker, 1962.
[i] Equal to Eden Valley in Scott and Barker, 1962.
[j] Equal to midpoint of most frequently occurring concentration range in domestic water histogram.

Table A2.25. Mississippi (total population 2 216 994[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Biloxi |  | 0.1[b] | 47 | 0.021 | 0.002 |
| Canton |  | 0.1[c] | 10.503 | 0.005 | 0.001 |
| Clarksdale |  | 0.1[d] | 22.5 | 0.010 | 0.001 |
| Greenville |  | 0.1[e] | 45 | 0.020 | 0.002 |
| Jackson | 0.1[f] |  | 170 | 0.077 | 0.008 |
| Meridian | 0.1[g] |  | 45 | 0.020 | 0.002 |
| Nonurban |  | 0.1[h] | 1876.991 | 0.847 | 0.085 |
| Total |  |  |  |  | 0.101 |

Population-weighted average concentration (μg/L) = 0.101
(pCi/L) = 0.069

Estimated per capita bone dose
Model I 0.101 × 10.2 = 1 mrem/year
Model II 0.101 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.

[b] Equal to average of Collins and Prentiss in Scott and Barker, 1962.

[c] Equal to Jackson in Durfor and Becker, 1964.

[d] Equal to Oxford in Scott and Barker, 1962.

[e] Equal to Baton Rouge in Durfor and Becker, 1964.

[f] Durfor and Becker, 1964.

[g] Scott and Barker, 1962.

[h] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.26. Missouri (total population 4 677 623[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Arnold | | 0.8[b] | 16.5 | 0.004 | 0.003 |
| Cape Girardeau | | 0.8[b] | 32 | 0.007 | 0.006 |
| Columbia | | 0.4[c] | 60 | 0.013 | 0.005 |
| Gladstone | | 0.2[d] | 27 | 0.006 | 0.001 |
| Hannibal | | 0.8[b] | 20 | 0.004 | 0.003 |
| Kansas City | 0.2[e] | | 632.724 | 0.135 | 0.027 |
| Marshall | | 0.4[c] | 12.2 | 0.003 | 0.001 |
| Raytown | | 0.2[d] | 17 | 0.004 | 0.001 |
| Sikeston | | 0.22[f] | 15.1 | 0.003 | 0.001 |
| Springfield | | 0.6[g] | 110 | 0.024 | 0.014 |
| St. Joseph | | 0.2[d] | 76.2 | 0.016 | 0.003 |
| St. Louis | 0.8[e] | | 622.5 | 0.133 | 0.106 |
| St. Louis County | | 0.8[b] | 764.512 | 0.163 | 0.130 |
| Nonurban | | 0.22[f] | 2271.887 | 0.486 | 0.107 |
| Total | | | | | 0.408 |

Population-weighted average concentration (μg/L) = 0.408
(pCi/L) = 0.277

Estimated per capita bone dose
Model I 0.408 × 10.2 = 4 mrem/year
Model II 0.408 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0–6

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[a] 1970 Census.

[b] Equal to St. Louis in Durfor and Becker, 1964.

[c] Equal to average of Ironton and Carthage in Scott and Barker, 1962.

[d] Equal to Kansas City in Durfor and Becker, 1964.

[e] Durfor and Becker, 1964.

[f] Equal to average of most frequently occurring concentration range in domestic water histogram.

[g] Equal to Carthage in Scott and Barker, 1962.

Table A2.27. Montana (total population 694 409[a])

| City or utility | Uranium in treated water (µg/L) Measured | Uranium in treated water (µg/L) Estimated | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| Billings | 0.5[b] | | 73.796 | 0.106 | 0.053 |
| Bozeman | 1.6[c] | | 17 | 0.024 | 0.038 |
| Great Falls | | 2.2[d] | 73 | 0.105 | 0.231 |
| Kalispell | | 2.2[d] | 10.5 | 0.015 | 0.033 |
| Missoula | | 2.2[d] | 48.227 | 0.069 | 0.152 |
| Nonurban | | 2.2[d] | 471.886 | 0.680 | 1.496 |
| Total | | | | | 2.003 |

Population-weighted average concentration (µg/L) = 2.003
(pCi/L) = 1.363

Estimated per capita bone dose
Model I 2.003 × 10.2 = 20 mrem/year
Model II 2.003 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-3
10 pCi/L = 0-10
5 pCi/L = 0-18
1 pCi/L = 53-80

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[a] 1970 Census.

[b] Well water latitude 45.7586 and longitude 108.4875 (near Billings) in Broxton, 1979.

[c] Stream water latitude 45.6484, longitude 111.0687 in Broxton, 1979.

[d] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.28. Nebraska (total population 1 485 333[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Beatrice |  | 0.4[b] | 12.392 | 0.008 | 0.003 |
| Bellevue |  | 2.6[c] | 10 | 0.007 | 0.018 |
| Fremont |  | 2.6[c] | 23 | 0.015 | 0.039 |
| Grand Island |  | 2.6[d] | 31 | 0.021 | 0.055 |
| Kearney |  | 2.6[d] | 19.18 | 0.013 | 0.034 |
| Lincoln | 5.2[e] |  | 149.518 | 0.101 | 0.525 |
| North Platte |  | 4.4[f] | 20 | 0.013 | 0.057 |
| Omaha | 2.6[e] |  | 425 | 0.286 | 0.744 |
| Nonurban |  | 2.2[g] | 795.243 | 0.535 | 1.177 |
| Total |  |  |  |  | 2.652 |

Population-weighted average concentration (μg/L) = 2.652
(pCi/L) = 1.803

Estimated per capita bone dose
Model I 2.652 × 10.2 = 27 mrem/year
Model II 2.652 × 0.381 = 1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-7
5 pCi/L = 0-28
1 pCi/L = 78-88

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[a] 1970 Census.
[b] Equal to Douglas in Scott and Barker, 1962.
[c] Equal to Omaha in Durfor and Becker, 1964.
[d] Equal to Aurora in Scott and Barker, 1962.
[e] Durfor and Becker, 1964.
[f] Equal to Imperial in Scott and Barker, 1962.
[g] Equal to midpoint of mode in domestic water histogram.

Table A2.29. Nevada (total population 488 738[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Las Vegas Valley Water District | 7.8[b] | | 200 | 0.409 | 3.190 |
| North Las Vegas | | 7.8[c] | 50.3 | 0.103 | 0.803 |
| Reno-Sierra Pacific Power | | 8.0[d] | 109 | 0.223 | 1.784 |
| Nonurban | | 2.2[e] | 129.438 | 0.265 | 0.583 |
| Total | | | | | 6.360 |

Population weighted average concentration (µg/L) = 6.360
(pCi/L) = 4.325

Estimated per capita bone dose
Model I 6.360 × 10.2 = 65 mrem/year
Model II 6.360 × 0.381 = 2 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-3
5 pCi/L = 15-100
1 pCi/L = 66-100

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[a] 1970 Census.

[b] U.S. Environmental Protection Agency, 1979.

[c] Equal to Las Vegas in U.S. Environmental Protection Agency, 1979.

[d] Median for Reno quadrangle in Bennett, 1980.

[e] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.30. New Hampshire (total population 737 681[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Nashua-Pennichuck Water | | 0.3[b] | 50 | 0.068 | 0.020 |
| Nonurban | | 0.05[c] | 687.681 | 0.932 | 0.047 |
| Total | | | | | 0.067 |

Population-weighted average concentration (µg/L) = 0.067
(pCi/L) = 0.046

**Estimated per capita bone dose**
Model I 0.067 × 10.2 = <1 mrem/year
Model II 0.067 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-0.4
10 pCi/L = 0-1
5 pCi/L = 0-2
1 pCi/L = 0-10

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[a] 1970 Census.
[b] Equal to Greenfield in Scott and Barker, 1962.
[c] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.31. New Jersey (total population 7 171 112[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Bloomfield | 0.1[b] |  | 52 | 0.007 | 0.001 |
| Bound Brook |  | 0.4[c] | 19.575 | 0.003 | 0.001 |
| Old Bridge-Madison Township |  |  | 57.838 | 0.008 | 0.002 |
| East Orange | 0.1[b] | 0.22[d] | 85 | 0.012 | 0.001 |
| Elizabeth-Elizabethtown Water Co. | 0.1[b] |  | 1251.672 | 0.175 | 0.018 |
| Glassboro |  | 0.2[e] | 13.5 | 0.002 | 0.000 |
| Haddon Heights-NJ Water Co. |  | 1.2[f] | 218.3 | 0.030 | 0.036 |
| Jersey City | 0.1[b] |  | 242 | 0.034 | 0.003 |
| Moorestown |  | 1.2[f] | 15.6 | 0.002 | 0.002 |
| Montclair |  | 0.1[g] | 44.043 | 0.006 | 0.001 |
| Newark | 0.1[b] |  | 352 | 0.049 | 0.005 |
| Nutley | 0.15[b] |  | 33 | 0.005 | 0.001 |
| Paterson | 0.15[b] |  | 136 | 0.019 | 0.003 |
| Perth Amboy |  | 0.1[g] | 40 | 0.006 | 0.001 |
| Phillipsburg | 0.4[h] |  | 45.5 | 0.006 | 0.002 |
| Rahway |  | 0.1[g] | 30 | 0.004 | 0.000 |
| Short Hills-Commonwealth Water |  | 0.22[d] | 232 | 0.032 | 0.007 |
| Vineland |  | 0.1[i] | 35 | 0.005 | 0.001 |
| Weehawken-Hackensack Water |  | 0.1[g] | 1000 | 0.139 | 0.014 |
| Other |  | 0.22[d] | 3278.084 | 0.457 | 0.101 |
| Total |  |  |  |  | 0.200 |

Population-weighted average concentration (μg/L) = 0.200
(pCi/L) = 0.136

Estimated per capita bone dose
Model I 0.200 × 10.2 = 2 mrem/year
Model II 0.200 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0-6

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[a] 1970 Census.

[b] Durfor and Becker, 1964.

[c] Equal to Phillipsburg in Scott and Barker, 1962.

[d] Equal to average of second most frequently occurring concentration range in domestic water histogram. Mode is 0-0.1 pCi/L.

[e] Equal to new Lisbon in Scott and Barker, 1962.

[f] Equal to Camden in Scott and Barker, 1962.

[g] Equal to Newark in Durfor and Becker, 1964.

[h] Scott and Barker, 1962.

[i] Equal to Woodbine in Scott and Barker, 1962.

Table A2.32. New Mexico (total population 1 017 055[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Albuquerque | 3.9[b] | | 250 | 0.246 | 0.959 |
| Clovis - Southwest Public Service | | 5.1[c] | 28.5 | 0.028 | 0.143 |
| Las Vegas | 2.2[d] | | 14.5 | 0.014 | 0.031 |
| Los Alamos | 0.1[e] | | 16 | 0.016 | 0.002 |
| Los Alamos - ZIA Co. | | 0.1[f] | 16 | 0.016 | 0.002 |
| Roswell | 1.0[d] | | 40 | 0.039 | 0.039 |
| Santa Fe | 0.9[d] | | 41.67 | 0.041 | 0.037 |
| Nonurban | | 5.1[c] | 610.385 | 0.600 | 3.060 |
| Total | | | | | 4.273 |

Population-weighted average concentration (μg/L) = 4.273
(pCi/L) = 2.906

Estimated per capita bone dose
Model I 4.273 × 10.2 = 44 mrem/year
Model II 4.273 × 0.381 = 2 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-2
10 pCi/L = 0-5
5 pCi/L = 0-12
1 pCi/L = 43-62

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[a] 1970 Census.
[b] Durfor and Becker, 1964.
[c] Average of most frequently occurring concentration range in domestic water histogram.
[d] Scott and Barker, 1962.
[e] Environmental Surveillance Group, 1979.
[f] Equal to Los Alamos in Environmental Surveillance Group, 1979.

Table A2.33. New York (total population 18 241 391[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Albany | 0.1[b] | | 109 | 0.006 | 0.001 |
| Albertson | | 0.51[c] | 13.5 | 0.001 | 0.001 |
| Batavia | | 0.1[d] | 17.214 | 0.001 | 0.000 |
| Beacon | | 1.5[e] | 13 | 0.001 | 0.002 |
| Binghampton | | 0.51[c] | 95 | 0.005 | 0.003 |
| Brentwood | | 0.7[f] | 25 | 0.001 | 0.001 |
| Buffalo | 0.2[b] | | 420 | 0.023 | 0.005 |
| Carle Place Water District | | 0.51[c] | 10 | 0.001 | 0.001 |
| Chappaqua - New Castle 1 | | 1.5[e] | 14.7 | 0.001 | 0.002 |
| Cortland | | 0.1[d] | 20 | 0.001 | 0.000 |
| Delmar - Bethleham District 1 | | 0.1[g] | 18 | 0.001 | 0.000 |
| East Meadow - Hempstead | | 0.7[f] | 150 | 0.008 | 0.006 |
| Elma | | 0.51[c] | 10 | 0.001 | 0.001 |
| Elmira | | 0.51[c] | 73 | 0.004 | 0.002 |
| Franklin Square | | 0.7[f] | 20 | 0.001 | 0.001 |
| Fredonia | | 0.2[h] | 10.328 | 0.001 | 0.000 |
| Fulton | | 0.1[d] | 14.255 | 0.001 | 0.000 |
| Garden City | | 0.7[f] | 24.483 | 0.001 | 0.001 |
| Geneseo | | 0.51[c] | 12 | 0.001 | 0.001 |
| Geneva | | 0.51[c] | 18 | 0.001 | 0.001 |
| Guilderland | | 0.1[g] | 11 | 0.001 | 0.000 |
| Hempstead | | 0.7[f] | 41.5 | 0.002 | 0.001 |
| Hicksville | | 0.7[f] | 60 | 0.003 | 0.002 |
| Huntington - S. Huntington Water | | 0.7[f] | 49.5 | 0.003 | 0.002 |
| Ilion | | 0.51[c] | 11 | 0.001 | 0.001 |
| Jamestown | | 0.51[c] | 46.299 | 0.003 | 0.002 |
| Johnson City | | 0.51[c] | 20.5 | 0.001 | 0.001 |
| Kingston | | 0.1[g] | 25 | 0.001 | 0.000 |
| Lockport | | 0.51[c] | 25 | 0.001 | 0.001 |
| Lynbrook - Long Island Water | | 0.7[f] | 262.4 | 0.014 | 0.010 |
| Mamaroneck - Westchester | | 0.22[i] | 60 | 0.003 | 0.001 |
| Massapequa | | 0.7[f] | 50 | 0.003 | 0.002 |
| New Rochelle | | 0.1[j] | 160.9 | 0.009 | 0.001 |
| Newark | | 0.51[c] | 15 | 0.001 | 0.001 |
| New Windsor | | 0.51[c] | 10 | 0.001 | 0.001 |
| New York City | 0.22[b] | | 7898 | 0.433 | 0.095 |
| Oakdale - Suffock Water | | 0.7[f] | 650 | 0.036 | 0.025 |
| Olean | | 0.51[c] | 20 | 0.001 | 0.001 |
| Ossining | | 1.5[e] | 26.9 | 0.001 | 0.002 |
| Plattsburg | | 1.0[k] | 18.715 | 0.001 | 0.001 |
| Port Washington | | 0.1[j] | 32 | 0.002 | 0.000 |
| Poughkeepsie | | 1.5[e] | 60 | 0.003 | 0.005 |
| Rochester | 0.1[b] | | 291.273 | 0.016 | 0.002 |
| Rome | | 0.1[d] | 40 | 0.002 | 0.000 |
| Schenectady | | 0.1[g] | 110 | 0.006 | 0.001 |
| South Farmingdale | | 0.7[f] | 49 | 0.003 | 0.002 |
| Syracuse | 0.1[b] | | 197.208 | 0.011 | 0.001 |
| Syracuse - Onondaga Co. | | 0.1[d] | 50 | 0.003 | 0.000 |
| Tarrytown | | 1.5[e] | 15 | 0.001 | 0.002 |
| Troy | | 0.1[g] | 100 | 0.005 | 0.001 |

Table A2.33 (continued)

| City or utility | Uranium in treated water (µg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Utica |  | 0.1[d] | 135 | 0.007 | 0.001 |
| Westbury | 0.7[b] |  | 24 | 0.001 | 0.001 |
| Yonkers | 0.1[b] |  | 198 | 0.011 | 0.001 |
| Other |  | 0.51[c] | 6390.716 | 0.350 | 0.179 |
| Total |  |  |  |  | 0.375 |

Population-weighted average concentration (µg/L) = 0.375
(pCi/L) = 0.255

Estimated per capita bone dose
Model I 0.375 × 10.2 = 4 mrem/year
Model II 0.375 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0–0.4
5 pCi/L = 0–2
1 pCi/L = 9–10

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[a] 1970 Census.

[b] Durfor and Becker, 1964.

[c] Average of third most frequently occurring concentration range in domestic water histogram. Mode is 0.02–0.05 pCi/L.

[d] Equal to Syracuse in Durfor and Becker, 1964.

[e] Equal to Carmel in Scott and Barker, 1962.

[f] Equal to Westbury in Scott and Barker, 1962.

[g] Equal to Albany in Durfor and Becker, 1964.

[h] Equal to Buffalo in Durfor and Becker, 1964.

[i] Equal to New York City in Durfor and Becker, 1964.

[j] Equal to Yonkers in Durfor and Becker, 1964.

[k] Equal to Bloomingdale in Scott and Barker, 1962.

Table A2.34. North Carolina (total population 5 084 411[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Asheville |  | 0.051[b] | 125 | 0.025 | 0.001 |
| Burlington |  | 0.1[c] | 40 | 0.008 | 0.001 |
| Charlotte | 0.1[d] |  | 11.704 | 0.002 | 0.000 |
| Durham |  | 0.051[b] | 132.681 | 0.026 | 0.001 |
| Fayetteville |  | 0.051[b] | 65 | 0.013 | 0.001 |
| Greensboro | 0.1[d] |  | 150 | 0.030 | 0.003 |
| Greenville |  | 0.051[b] | 29 | 0.006 | 0.000 |
| Hendersonville |  | 0.1[e] | 23 | 0.005 | 0.001 |
| Lenoir |  | 0.9[f] | 20 | 0.004 | 0.004 |
| Lexington |  | 0.051[b] | 24.4 | 0.005 | 0.000 |
| New Bern |  | 0.3[g] | 20 | 0.004 | 0.001 |
| Wilmington |  | 0.3[g] | 44 | 0.009 | 0.003 |
| Nonurban |  | 0.051[b] | 4399.626 | 0.865 | 0.044 |
| Total |  |  |  |  | 0.060 |

Population-weighted average concentration (μg/L) = 0.060
(pCi/L) = 0.041

Estimated per capita bone dose
Model I 0.060 × 10.2 = 1 mrem/year
Model II 0.060 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-0.2
10 pCi/L = 0-0.4
5 pCi/L = 0-0.9
1 pCi/L = 0-3

---

[a] 1970 Census.

[b] Equal to average of second most frequently occurring concentration range in domestic water histogram. Mode is 0-0.01 pCi/L.

[c] Equal to Greensboro in Durfor and Becker, 1964.

[d] Durfor and Becker, 1964.

[e] Equal to Charlotte in Durfor and Becker, 1964.

[f] Equal to Farmer in Scott and Barker, 1962.

[g] Equal to Wallace in Scott and Barker, 1962.

Table A2.35. North Dakota (total population 617 792[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Bismarck | 0.18[b] | | 34.703 | 0.056 | 0.010 |
| Fargo | | 0.3[c] | 53.460 | 0.087 | 0.026 |
| Grand Forks | 0.3[d] | | 58.5 | 0.095 | 0.029 |
| Nonurban | | 0.5[e] | 471.129 | 0.763 | 0.382 |
| Total | | | | | 0.447 |

Population-weighted average concentration (µg/L) = 0.447
(pCi/L) = 0.304

Estimated per capita bone dose
Model I 0.447 × 10.2 = 5 mrem/year
Model II 0.447 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.
[b] U.S. Environmental Protection Agency, 1979.
[c] Equal to Grand Forks in Scott and Barker, 1962.
[d] Scott and Barker, 1962.
[e] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.36. Ohio (total population 10 657 423[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Akron | 0.1[b] | | 380 | 0.036 | 0.004 |
| Alliance | | 0.5[c] | 32.567 | 0.003 | 0.002 |
| Ashland | | 0.5[c] | 20 | 0.002 | 0.001 |
| Avon Lake | | 0.1[d] | 12.5 | 0.001 | 0.000 |
| Barberton | | 0.1[e] | 35 | 0.003 | 0.000 |
| Chillicothe | | 0.1[f] | 25 | 0.002 | 0.000 |
| Cincinnati | 0.1[b] | | 404 | 0.038 | 0.004 |
| Cleveland | 0.3[b] | | 660 | 0.062 | 0.019 |
| Columbus | 0.1[b] | | 582 | 0.055 | 0.006 |
| Coshocton | | 0.1[f] | 15 | 0.001 | 0.000 |
| Cuyahoga Falls | | 0.1[e] | 60 | 0.006 | 0.001 |
| Dayton | 0.1[b] | | 350 | 0.033 | 0.003 |
| Defiance | | 0.1[f] | 20 | 0.002 | 0.000 |
| Delaware | | 1.9[g] | 15.5 | 0.001 | 0.002 |
| Dover | | 0.1[f] | 12 | 0.001 | 0.000 |
| Mansfield | | 1.0[h] | 60 | 0.006 | 0.006 |
| Marietta | | 0.1[i] | 20 | 0.002 | 0.000 |
| Massilon-Ohio Water Service | | 0.5[c] | 52.28 | 0.005 | 0.003 |
| New Philadelphia | | 0.1[f] | 15 | 0.001 | 0.000 |
| Norwalk | | 0.1[f] | 14.3 | 0.001 | 0.000 |
| Piqua | | 0.9[j] | 22 | 0.002 | 0.002 |
| Reynoldsburg | | 0.1[k] | 14 | 0.001 | 0.000 |
| Shelby | | 1.0[l] | 14.203 | 0.001 | 0.001 |
| Sidney | 0.9[m] | | 17 | 0.002 | 0.002 |
| Steubenville | | 0.1[i] | 40 | 0.004 | 0.000 |
| Struthers-Ohio Water Service | | 0.1[i] | 34 | 0.003 | 0.000 |
| Toledo | 0.1[b] | | 366 | 0.034 | 0.003 |
| Troy | | 0.9[j] | 17 | 0.002 | 0.002 |
| Wadsworth | | 0.1[e] | 13.142 | 0.001 | 0.000 |
| West Carrollton | | 1.8[n] | 10 | 0.001 | 0.002 |
| Xenia | | 1.8[n] | 26 | 0.002 | 0.004 |
| Youngstown | 0.1[b] | | 128.5 | 0.012 | 0.001 |
| Other | | 0.1[f] | 7170.431 | 0.673 | 0.067 |
| Total | | | | | 0.135 |

Population-weighted average concentration (μg/L) = 0.135
(pCi/L) = 0.092

Estimated per capita bone dose
Model I 0.135 × 10.2 = 1 mrem/year
Model II 0.135 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 9-18

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[a] 1970 Census.

[b] Durfor and Becker, 1964.

[c] Equal to Canton in Scott and Barker, 1962.

[d] Equal to Toledo in Durfor and Becker, 1964.

[e] Equal to Akron in Durfor and Becker, 1964.

[f] Equal to average of most frequently occurring concentration range in domestic water histogram.

[g] Equal to Marysville in Scott and Barker, 1962.

[h] Equal to Marion in Scott and Barker, 1962.

[i] Equal to Youngstown in Durfor and Becker, 1964.

[j] Equal to Sidney in Scott and Barker, 1962.

[k] Equal to Columbus in Durfor and Becker, 1964.

[l] Equal to Marion in Scott and Barker, 1962.

[m] Scott and Barker, 1962.

[n] Equal to Franklin in Kennedy, Bartlet, and Orlandini, 1977.

Table A2.37. Oklahoma (total population 2 559 463[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Cushing | | 5.1[b] | 10 | 0.004 | 0.020 |
| Del City | | 0.3[c] | 28 | 0.011 | 0.003 |
| Enid | | 5.1[b] | 45.5 | 0.018 | 0.092 |
| Oklahoma City | 0.3[d] | | 378 | 0.148 | 0.044 |
| Norman | 12[e] | | 52.117 | 0.020 | 0.240 |
| Tulsa | 0.2[d] | | 395 | 0.154 | 0.031 |
| Nonurban | | 5.1[b] | 1650.846 | 0.645 | 3.290 |
| Total | | | | | 3.720 |

Population-weighted average concentration (μg/L) = 3.720
(pCi/L) = 2.530

Estimated per capita bone dose
Model I 3.720 × 10.2 = 38 mrem/year
Model II 3.720 × 0.381 = 1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-4
10 pCi/L = 0-9
5 pCi/L = 17-20
1 pCi/L = 50-53

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[a] 1970 Census.

[b] Equal to average of second most frequently occurring concentration in domestic water histogram. Mode is 2.0-5.0 pCi/L.

[c] Equal to Oklahoma City in Durfor and Becker, 1964.

[d] Durfor and Becker, 1964.

[e] Scott and Barker, 1962.

Table A2.38. Oregon (total population 2 091 533[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Ashland | | 0.1[b] | 13 | 0.006 | 0.001 |
| Bend | | 0.6[c] | 15.7 | 0.008 | 0.005 |
| Clackamas | | 0.2[d] | 12.5 | 0.006 | 0.001 |
| Coos Bay-North Bend | | 0.1[e] | 30 | 0.014 | 0.001 |
| Corvallis | | 0.1[e] | 35 | 0.017 | 0.002 |
| Eugene | | 0.1[e] | 73.346 | 0.035 | 0.004 |
| Grants Pass | | 0.1[b] | 12.5 | 0.006 | 0.001 |
| Medford | | 0.1[b] | 35.694 | 0.017 | 0.002 |
| Milwaukie | | 0.2[d] | 16.5 | 0.008 | 0.002 |
| Portland | 0.2[f] | | 650 | 0.311 | 0.062 |
| Portland-Parkrose Water District | | 0.2[d] | 16 | 0.008 | 0.002 |
| Portland-Powell Valley Water | | 0.2[d] | 25 | 0.012 | 0.002 |
| Portland-Wolf Creek Water | | 0.2[d] | 25.2 | 0.012 | 0.002 |
| Salem | | 0.1[e] | 72 | 0.034 | 0.003 |
| Salem-Kiezer Water District | | 0.1[e] | 11.4 | 0.005 | 0.001 |
| The Dalles | | 0.2[d] | 10.9 | 0.005 | 0.001 |
| Nonurban | | 0.1[g] | 1036.793 | 0.496 | 0.050 |
| Total | | | | | 0.142 |

Population-weighted average concentration (μg/L) = 0.142
(pCi/L) = 0.097

Estimated per capita bone dose
Model I 0.142 × 10.2 = 1 mrem/year
Model II 0.142 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.

[b] Equal to Cane Junction in Scott and Barker, 1962.

[c] Equal to Madras in Scott and Barker, 1962.

[d] Equal to Portland in Durfor and Becker, 1964.

[e] Equal to Monroe in Scott and Barker, 1962.

[f] Durfor and Becker, 1964.

[g] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.39. Pennsylvania (total population 11 800 766[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Bradford | | 0.051[b] | 18 | 0.002 | 0.000 |
| Bryn Mawr-Phila. Suburban Water | | 0.1[c] | 808 | 0.068 | 0.007 |
| Charleroi | | 0.5[d] | 45 | 0.004 | 0.002 |
| Chester | | 0.1[c] | 115 | 0.010 | 0.001 |
| Coatesville | | 0.8[e] | 18 | 0.002 | 0.002 |
| Creswell Heights | | 0.1[f] | 13.2 | 0.001 | 0.000 |
| Doylestown-Bucks City Water | | 2.3[g] | 52 | 0.004 | 0.009 |
| Du Bois | | 0.2[h] | 15 | 0.001 | 0.000 |
| Erie | 0.3[i] | | 200 | 0.017 | 0.005 |
| Fallsington-Falls Township | | 0.051[b] | 11 | 0.001 | 0.000 |
| Glenshaw-Shaler Township | | 0.5[d] | 40 | 0.003 | 0.002 |
| Harrisburg | 0.1[j] | | 626 | 0.053 | 0.005 |
| Hatboro | | 0.1[c] | 15 | 0.001 | 0.000 |
| Hershey | | 0.1[f] | 17 | 0.001 | 0.000 |
| Lancaster | | 0.8[e] | 150 | 0.013 | 0.010 |
| Lansford-Coaldale Junction | | 0.7[k] | 12.166 | 0.001 | 0.001 |
| Lewistown | | 0.3[l] | 33 | 0.003 | 0.001 |
| McDonald-West Penn. Water | | 0.5[d] | 11.8 | 0.001 | 0.001 |
| Meadville | | 0.051[b] | 18.72 | 0.002 | 0.000 |
| Middletown | | 0.1[f] | 10.5 | 0.001 | 0.000 |
| Monaca | | 0.5[d] | 10.598 | 0.001 | 0.001 |
| Monroeville | | 0.5[d] | 30 | 0.003 | 0.002 |
| Norristown | | 0.1[c] | 69.7 | 0.006 | 0.001 |
| North Versailles Township | | 0.1[m] | 15 | 0.001 | 0.000 |
| North Wales Water Authority | | 0.051[b] | 20 | 0.002 | 0.000 |
| Northampton | | 0.051[b] | 35 | 0.003 | 0.000 |
| Oakmont | | 0.5[d] | 57.1 | 0.005 | 0.003 |
| Philadelphia | 0.1[i] | | 1820 | 0.154 | 0.015 |
| Pittsburgh-S. Pittsburgh Water Co. | 0.1[i] | | 513.237 | 0.043 | 0.004 |
| Pottstown | | 1.4[n] | 35 | 0.003 | 0.004 |
| Reading | | 0.051[b] | 125 | 0.011 | 0.001 |
| Reading-Muhlenberg Township | | 0.051[b] | 13 | 0.001 | 0.000 |
| Sharon-Shenango Valley | | 0.051[b] | 70 | 0.006 | 0.000 |
| Shenandoah | | 0.051[b] | 15 | 0.001 | 0.000 |
| Sunbury | | 0.1[f] | 14.5 | 0.001 | 0.000 |
| Tyrone | | 0.051[b] | 10 | 0.001 | 0.000 |
| Uniontown-N. Fayette Authority | | 0.051[b] | 24.472 | 0.002 | 0.000 |
| Uniontown-Uniontown Water Co. | | 0.051[b] | 29.75 | 0.003 | 0.000 |
| Warminster | | 0.051[b] | 26 | 0.002 | 0.000 |
| Washington-West Penn. Water Co. | | 0.5[d] | 22.904 | 0.002 | 0.001 |
| Waynesboro | | 0.051[b] | 13.5 | 0.001 | 0.000 |
| West Chester | | 1.4[n] | 22 | 0.002 | 0.003 |
| West View | | 0.5[d] | 160 | 0.014 | 0.007 |
| York | | 1.2[o] | 118 | 0.010 | 0.012 |
| Other | | 0.051[b] | 6301.619 | 0.534 | 0.027 |
| Total | | | | | 0.127 |

Table A2.39 (continued)

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |

Population-weighted average concentration (μg/L) = 0.127
(pCi/L) = 0.086

Estimated per capita bone dose
Model I 0.127 × 10.2 = 1 mrem/year
Model II 0.127 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-0.07
5 pCi/L = 0-0.3
1 pCi/L = 2-5

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[a] 1970 Census.

[b] Average of second most frequently occurring concentration range in domestic water histogram. Mode is 0-0.01 pCi/L.

[c] Equal to Philadelphia in Durfor and Becker, 1964.

[d] Equal to Avonmore in Scott and Barker, 1962.

[e] Equal to Lititz in Scott and Barker, 1962.

[f] Equal to Harrisburg in U.S. Environmental Protection Agency, 1979.

[g] Equal to Lansdale in Scott and Barker, 1962.

[h] Equal to Armstrong in Scott and Barker, 1962.

[i] Durfor and Becker, 1964.

[j] U.S. Environmental Protection Agency, 1979.

[k] Equal to spring one mile NW of Jim Thorpe in Scott and Barker, 1962.

[l] Equal to Summerdale in Scott and Barker, 1962.

[m] Equal to Pittsburgh in Durfor and Becker, 1964.

[n] Equal to average of Lansdale and Ambler in Scott and Barker, 1962.

[o] Equal to Shilah in Scott and Barker, 1962.

Table A2.40. Rhode Island (total population 949 723[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Alton | 0.1[b] |  | 0.3 | 0.000 | 0.000 |
| East Providence | 0.5[b] |  | 46.8 | 0.049 | 0.025 |
| Providence | 0.1[c] |  | 383.134 | 0.403 | 0.040 |
| West Warwick | 1.4[b] |  | 24.323 | 0.026 | 0.036 |
| Other |  | 0.1[d] | 495.166 | 0.521 | 0.052 |
| Total |  |  |  |  | 0.153 |

Population-weighted average concentration (μg/L) = 0.153
(pCi/L) = 0.104

Estimated per capita bone dose
Model I 0.153 × 10.2 = 2 mrem/year
Model II 0.153 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 0

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[a] 1970 Census.
[b] Scott and Barker, 1962.
[c] Durfor and Becker, 1964.
[d] Average of most frequently occurring concentration range in domestic water histogram.

Table A2.41. South Carolina (total population 2 590 835[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Anderson | | 0.051[b] | 50 | 0.019 | 0.001 |
| Beaufort-Jasper | | 2.1[c] | 35 | 0.014 | 0.029 |
| Charleston | | 0.3[d] | 175.899 | 0.068 | 0.020 |
| Chester | | 1.5[e] | 12.5 | 0.005 | 0.008 |
| Columbia | 0.1[f] | | 99 | 0.038 | 0.004 |
| Greenville | | 2.3[g] | 200 | 0.077 | 0.177 |
| Greenwood | | 0.4[h] | 34.822 | 0.013 | 0.005 |
| Greer | | 2.3[g] | 10.5 | 0.004 | 0.009 |
| Laurens | | 1.5[e] | 12 | 0.005 | 0.008 |
| Newberry | | 1.5[e] | 10 | 0.004 | 0.006 |
| Sourtex-Jackson-Willford-Duncan | | 0.051[b] | 20 | 0.008 | 0.000 |
| Nonurban | | 0.051[b] | 1931.114 | 0.745 | 0.038 |
| Total | | | | | 0.305 |

Population-weighted average concentration (µg/L) = 0.305
(pCi/L) = 0.207

Estimated per capita bone dose
Model I 0.305 × 10.2 = 3 mrem/year
Model II 0.305 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-0.1
10 pCi/L = 0-0.2
5 pCi/L = 0-0.3
1 pCi/L = 2-54

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[a] 1970 Census.
[b] Average of most frequently occurring concentration range in domestic water histogram.
[c] Equal to Parris Island in Scott and Barker, 1962.
[d] Equal to Georgetown in Scott and Barker, 1962.
[e] Equal to West Spring in Scott and Barker, 1962.
[f] U.S. Environmental Protection Agency, 1979.
[g] Equal to Greenville in Scott and Barker, 1962.
[h] Equal to John de la Howe School, McCormick County in Scott and Barker, 1962.

Table A2.42. South Dakota (total population 666 257[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Aberdeen | | 11.0[b] | 26 | 0.039 | 0.429 |
| Brookings | | 8.1[c] | 13.5 | 0.020 | 0.162 |
| Rapid City | | 1.0[d] | 45 | 0.068 | 0.068 |
| Sioux Falls | | 8.1[c] | 72.444 | 0.109 | 0.883 |
| Watertown | | 11.0[b] | 15 | 0.023 | 0.253 |
| Yankton | | 8.1[c] | 12.5 | 0.019 | 0.154 |
| Nonurban | | 11.0[b] | 481.813 | 0.723 | 7.953 |
| Total | | | | | 9.902 |

Population-weighted average concentration (μg/L) = 9.902
(pCi/L) = 6.733

Estimated per capita bone dose
Model I 9.902 × 10.2 = 101 mrem/year
Model II 9.902 × 0.381 = 4 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-12
10 pCi/L = 0-31
5 pCi/L = 55-83
1 pCi/L = 78-83

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[a] 1970 Census.

[b] Equal to average of most frequently occurring concentration range in domestic water histogram.

[c] Equal to site one mile west of Sioux Falls in Scott and Barker, 1962.

[d] Equal to site three miles SW of Sturgis in Scott and Barker, 1962.

Table A2.43. Tennessee (total population 3 926 018[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Athens | | 0.5[b] | 17 | 0.004 | 0.002 |
| Brownsville | | 0.5[c] | 10 | 0.003 | 0.002 |
| Chattanooga | 0.5[d] | | 144.5 | 0.037 | 0.019 |
| Cleveland | | 0.5[b] | 30 | 0.008 | 0.004 |
| Cookeville | | 0.3[e] | 20 | 0.005 | 0.002 |
| Columbia | | 0.3[f] | 35 | 0.009 | 0.003 |
| Concord-Knox City District | | 0.1[g] | 10.5 | 0.003 | 0.000 |
| Greeneville | | 0.1[g] | 25 | 0.006 | 0.001 |
| Kingsport | | 0.051[h] | 42.75 | 0.011 | 0.001 |
| Knoxville | 0.1[i] | | 185 | 0.047 | 0.005 |
| Madison Utility District | | 0.1[j] | 30 | 0.008 | 0.001 |
| Memphis | 0.1[d] | | 623.53 | 0.159 | 0.016 |
| Morristown | | 0.1[g] | 31 | 0.008 | 0.001 |
| Murfreesboro | | 0.3[e] | 26.36 | 0.007 | 0.002 |
| Nashville | 0.1[d] | | 360 | 0.092 | 0.009 |
| Oak Ridge | | 0.1[g] | 30 | 0.008 | 0.001 |
| Paris | | 0.1[k] | 10 | 0.003 | 0.000 |
| Shelbyville | | 0.3[f] | 15 | 0.004 | 0.001 |
| Springfield | | 0.051[h] | 10 | 0.003 | 0.000 |
| Tullahoma | | 0.3[e] | 15 | 0.004 | 0.001 |
| Nonurban | | 0.051[h] | 2255.378 | 0.574 | 0.029 |
| Total | | | | | 0.100 |

Population-weighted average concentration (μg/L) = 0.100
(pCi/L) = 0.068

Estimated per capita bone dose
Model I 0.100 × 10.2 = 1 mrem/year
Model II 0.100 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-0
10 pCi/L = 0-0
5 pCi/L = 0-0
1 pCi/L = 0-0

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[a] 1970 Census.

[b] Equal to Chattanooga in Durfor and Becker, 1964.

[c] Equal to Lexington in Scott and Barker, 1962.

[d] Durfor and Becker, 1964.

[e] Equal to McMinnville in Scott and Barker, 1962.

[f] Equal to Camden in Scott and Barker, 1962.

[g] Equal to Knoxville in U.S. Environmental Protection Agency, 1979.

[h] Equal to average of second most frequently occurring concentration range in domestic water histogram. Mode is 0-0.01 pCi/L.

[j] Equal to Nashville in Durfor and Becker, 1964.

[k] Equal to Huntingdon in Scott and Barker, 1962.

Table A2.44. Texas (total population 11 198 655[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Alice |  | 0.2[b] | 25 | 0.002 | 0.000 |
| Amarillo | 6.3[c] |  | 127.01 | 0.011 | 0.069 |
| Arlington |  | 1.4[d] | 100 | 0.009 | 0.013 |
| Austin | 0.1[c] |  | 250 | 0.022 | 0.002 |
| Corpus Christi | 0.9[c] |  | 274.716 | 0.025 | 0.023 |
| Dallas | 0.2[c] |  | 1130 | 0.101 | 0.020 |
| Eagle Pass |  | 0.2[e] | 15.5 | 0.001 | 0.000 |
| El Paso | 2.8[c] |  | 330 | 0.029 | 0.081 |
| Fort Worth | 1.4[c] |  | 365 | 0.033 | 0.046 |
| Garland |  | 0.2[f] | 87 | 0.008 | 0.002 |
| Greenville |  | 5.1[g] | 23 | 0.002 | 0.010 |
| Harlingen |  | 5.1[g] | 40 | 0.004 | 0.020 |
| Houston | 1.8[c] |  | 1076 | 0.096 | 0.173 |
| Kerrville |  | 0.2[h] | 12 | 0.001 | 0.000 |
| Levelland |  | 1.4[i] | 11.445 | 0.001 | 0.001 |
| Lubbock | 30.2[c] |  | 170 | 0.015 | 0.453 |
| McAllen |  | 5.1[g] | 40 | 0.004 | 0.020 |
| Midland |  | 1.6[j] | 59.463 | 0.005 | 0.008 |
| Mineral Wells |  | 5.1[g] | 18 | 0.002 | 0.010 |
| New Braunfels |  | 0.3[k] | 17.859 | 0.002 | 0.001 |
| Pecos |  | 0.9[l] | 15.185 | 0.001 | 0.001 |
| Plainview |  | 11.0[m] | 19.091 | 0.002 | 0.022 |
| San Angelo |  | 0.2[h] | 65 | 0.006 | 0.001 |
| San Antonio | 0.3[c] |  | 578.855 | 0.052 | 0.016 |
| San Antonio-Bexar Metropolitan Water |  | 0.3[k] | 125 | 0.011 | 0.003 |
| Sherman |  | 5.1[g] | 29.061 | 0.003 | 0.015 |
| Temple |  | 0.1[n] | 37 | 0.003 | 0.000 |
| Tyler |  | 5.1[g] | 57 | 0.005 | 0.026 |
| Weatherford |  | 5.1[g] | 11.75 | 0.001 | 0.005 |
| W. University Place |  | 1.8[o] | 13.317 | 0.001 | 0.002 |
| White Settlement |  | 1.4[d] | 13.5 | 0.001 | 0.001 |
| Other |  | 5.1[g] | 6061.903 | 0.541 | 2.759 |
| Total |  |  |  |  | 3.803 |

Population-weighted average concentration (μg/L) = 3.803
(pCi/L) = 2.586

Estimated per capita bone dose
Model I 3.803 × 10.2 = 39 mrem/year
Model II 3.803 × 0.381 = 1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 2-3
10 pCi/L = 3-7
5 pCi/L = 7-16
1 pCi/L = 39-47

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[a] 1970 Census.

[b] Equal to Karnes in Scott and Barker, 1962.

[c] Durfor and Becker, 1964.

[d] Equal to Fort Worth in Durfor and Becker, 1964.

[e] Equal to Crystal City in Scott and Barker, 1962.

[f] Equal to Dallas in Durfor and Becker, 1964.

[g] Equal to average of second most frequently occurring concentration range in domestic water histogram. Mode is 0.1-0.2 pCi/L.

[h] Equal to Eden in Scott and Barker, 1962.

[i] Equal to Colorado City in Scott and Barker, 1962.

[j] Equal to Kermit in Scott and Barker, 1962.

[k] Equal to San Antonio in Durfor and Becker, 1964.

[l] Equal to Valentine in Scott and Barker, 1962.

[m] Equal to well water sample 5709 in Nichols et al., 1977.

[n] Equal to Manor in Scott and Barker, 1962.

[o] Equal to Houston in Durfor and Becker, 1964.

Table A2.45. Utah (total population 1 059 273[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Bountiful | | 5.3[b] | 27.853 | 0.026 | 0.138 |
| Murray | | 0.6[c] | 22.5 | 0.021 | 0.013 |
| Ogden-Pineview Water System | | 0.1[d] | 75 | 0.071 | 0.007 |
| Salt Lake City | 0.6[e] | | 400 | 0.378 | 0.227 |
| Salt Lake County Water District | | 0.6[c] | 350 | 0.330 | 0.198 |
| Nonurban | | 1.1[f] | 183.92 | 0.174 | 0.191 |
| Total | | | | | 0.774 |

Population-weighted average concentration (µg/L) = 0.774
(pCi/L) = 0.526

Estimated per capita bone dose
Model I 0.774 × 10.2 = 8 mrem/year
Model II 0.774 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 20-33

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[a] 1970 Census.
[b] Equal to Leytona in Scott and Barker, 1962.
[c] Equal to Salt Lake City in Durfor and Becker, 1964.
[d] Equal to site one mile southwest of Ogden in Scott and Barker, 1962.
[e] Durfor and Becker, 1964.
[f] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.46. Vermont (total population 444 732[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Urban and nonurban | | 0.051[b] | 444.732 | 1.0 | 0.051 |

Population-weighted average concentration (µg/L) = 0.051
(pCi/L) = 0.035

Estimated per capita bone dose
Model I 0.051 × 10.2 = 1 mrem/year
Model II 0.051 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0-0.5
5 pCi/L = 0-2
1 pCi/L = 0-9

---

[a] 1970 Census.
[b] Equal to average of second most frequently occurring concentration range in domestic water histogram. Mode is 0-0.01 pCi/L.

Table A2.47. Virginia (total population 4 651 448[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Annadale-Fairfax County | | 0.1[b] | 477 | 0.103 | 0.010 |
| Bedford | | 0.1[c] | 10.5 | 0.002 | 0.000 |
| Bristol | | 0.051[d] | 14.857 | 0.003 | 0.000 |
| Chesterfield Court House | | 0.2[e] | 53 | 0.011 | 0.002 |
| Danville | | 0.051[d] | 50 | 0.011 | 0.001 |
| Fairfax | | 0.1[f] | 40 | 0.009 | 0.001 |
| Leesburg-Loudon County Sanitation | | 0.1[f] | 10 | 0.002 | 0.000 |
| Norfolk | 0.1[g] | | 500 | 0.107 | 0.011 |
| Portsmouth | | 0.1[h] | 150 | 0.032 | 0.003 |
| Radford | | 0.051[d] | 15 | 0.003 | 0.000 |
| Richmond | 0.2[g] | | 250 | 0.054 | 0.011 |
| Richmond-Henrico County | | 0.2[e] | 114.168 | 0.025 | 0.005 |
| Roanoke | | 0.1[c] | 125 | 0.027 | 0.003 |
| Vienna | | 0.1[f] | 21 | 0.005 | 0.001 |
| Nonurban | | 0.051[d] | 2820.923 | 0.606 | 0.031 |
| Total | | | | | 0.079 |

Population-weighted average concentration (μg/L) = 0.079
(pCi/L) = 0.054

Estimated per capita bone dose
Model I 0.079 × 10.2 = 1 mrem/year
Model II 0.079 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0–0.3
10 pCi/L = 0–0.5
5 pCi/L = 0–0.6
1 pCi/L = 0–3

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[a] 1970 Census.

[b] Equal to District of Columbia in Durfor and Becker, 1964.

[c] Equal to Lynchburg in U.S. Environmental Protection Agency, 1979.

[d] Equal to average of most frequently occurring concentration range in domestic water histogram.

[e] Equal to Richmond in Durfor and Becker, 1964.

[f] Equal to Fredricksburg in Scott and Becker, 1962.

[g] Durfor and Becker, 1964.

[h] Equal to Norfolk in Durfor and Becker, 1964.

Table A2.48. Washington (total population 3 413 244[a])

| City or utility | Uranium in treated water (μg/L) |  | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
|  | Measured | Estimated |  |  |  |
| Auburn |  | 0.2[b] | 22 | 0.006 | 0.001 |
| Bellevue-King City Water 68 |  | 0.1[c] | 30 | 0.009 | 0.001 |
| Bellevue-King City Water 107 |  | 0.1[c] | 10.5 | 0.003 | 0.000 |
| Bremerton |  | 0.1[d] | 45 | 0.013 | 0.001 |
| Ellensburg | 0.1[e] |  | 13.6 | 0.004 | 0.000 |
| Everett |  | 0.1[c] | 154 | 0.045 | 0.005 |
| Hoquiam |  | 0.1[d] | 10.466 | 0.003 | 0.000 |
| Kenmore-King City Water 79 |  | 0.1[c] | 31 | 0.009 | 0.001 |
| Kennewick |  | 0.1[f] | 25 | 0.007 | 0.001 |
| Kirkland-King City Water 81 |  | 0.1[c] | 12.5 | 0.004 | 0.000 |
| Longview |  | 0.2[g] | 33 | 0.010 | 0.002 |
| Lynnwood |  | 0.1[c] | 16.222 | 0.005 | 0.001 |
| Lynnwood-Alderwood District |  | 0.1[c] | 44 | 0.013 | 0.001 |
| Moses Lake | 0.1[h] |  | 13 | 0.004 | 0.000 |
| Mountlake Terrace |  | 0.1[c] | 16.7 | 0.005 | 0.001 |
| Mt. Vernon-Skagit County |  | 0.1[c] | 30 | 0.009 | 0.001 |
| Olympia |  | 0.2[b] | 30 | 0.009 | 0.002 |
| Puyallup |  | 0.2[b] | 16 | 0.005 | 0.001 |
| Renton |  | 0.1[c] | 25.258 | 0.007 | 0.001 |
| Seattle | 0.1[i] |  | 573.154 | 0.168 | 0.017 |
| Seattle-King City Water 49 |  | 0.1[c] | 25 | 0.007 | 0.001 |
| Seattle-King City Water 20 |  | 0.1[c] | 28 | 0.008 | 0.001 |
| Seattle-King City Water 61 |  | 0.1[c] | 30 | 0.009 | 0.001 |
| Seattle-King City Water 75 |  | 0.1[c] | 45 | 0.013 | 0.001 |
| Spokane | 3.7[i] |  | 171.8 | 0.050 | 0.185 |
| Spokane-Modern Electric and Water |  | 3.7[j] | 16 | 0.005 | 0.019 |
| Spokane-Washington Water |  | 3.7[j] | 16.5 | 0.005 | 0.019 |
| Tacoma | 0.2[i] |  | 175 | 0.051 | 0.010 |
| Vancouver-Clark City Utility | 0.2[h] |  | 13.51 | 0.004 | 0.001 |
| Nonurban |  | 1.1[e] | 1741.034 | 0.510 | 0.561 |
| Total |  |  |  |  | 0.836 |

Population-weighted average concentration (μg/L) = 0.836
(pCi/L) = 0.568

Estimated per capita bone dose
Model I 0.836 × 10.2 = 9 mrem/year
Model II 0.836 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-1
10 pCi/L = 0-3
5 pCi/L = 0-10
1 pCi/L = 10-41

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[a] 1970 Census.

[b] Equal to Tacoma in Scott and Barker, 1962.

[c] Equal to Seattle in Durfor and Becker, 1964.

[d] Equal to Port Angeles in Scott and Barker, 1962.

[e] Average of most frequently occurring concentration range in domestic water histogram.

[f] Equal to Moses Lake in Scott and Barker, 1962.

[g] Equal to Vancouver in Scott and Barker, 1962.

[h] Scott and Barker, 1962.

[i] Durfor and Becker, 1964.

[j] Equal to Spokane in Durfor and Becker, 1964.

Table A2.49. West Virginia (total population 1 744 237[a])

| City or utility | Uranium in treated water (µg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Morgantown | | 1.5[b] | 43.5 | 0.025 | 0.038 |
| Parkersburg | 0.1[c] | | 60 | 0.034 | 0.003 |
| Weirton | | 0.1[d] | 27.131 | 0.016 | 0.002 |
| Nonurban | | 1.1[e] | 1613.6 | 0.925 | 1.018 |
| Total | | | | | 1.061 |

Population-weighted average concentration (µg/L) = 1.061
(pCi/L) = 0.721

Estimated per capita bone dose
Model I 1.061 × 10.2 = 11 mrem/year
Model II 1.061 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0
10 pCi/L = 0
5 pCi/L = 0
1 pCi/L = 20–33

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[a] 1970 Census.
[b] Equal to Blacksville in Scott and Barker, 1962.
[c] Scott and Barker, 1962.
[d] Equal to Mannington in Scott and Barker, 1962.
[e] Equal to average of most frequently occurring concentration range in domestic water histogram.

Table A2.50. Wisconsin (total population 4 417 821[a])

| City or utility | Uranium in treated water (μg/L) | | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| | Measured | Estimated | | | |
| Allouez-Green Bay | | 0.5[b] | 16 | 0.004 | 0.002 |
| Appleton | | 0.5[b] | 57 | 0.013 | 0.007 |
| Beaver Dam | | 0.22[c] | 14.233 | 0.003 | 0.001 |
| Chippewa Falls | | 0.5[d] | 16 | 0.004 | 0.002 |
| Eau Claire | | 0.5[d] | 44 | 0.010 | 0.005 |
| Fond du Lac | | 0.5[b] | 35 | 0.008 | 0.004 |
| Glendale | | 0.1[e] | 14 | 0.003 | 0.000 |
| Green Bay | | 0.1[e] | 87.5 | 0.020 | 0.002 |
| Greendale | | 0.1[e] | 15 | 0.003 | 0.000 |
| Janesville | | 0.1[f] | 46.426 | 0.011 | 0.001 |
| Kaukauna | | 0.5[b] | 11.232 | 0.003 | 0.002 |
| Kenosha | | 0.1[e] | 83.5 | 0.019 | 0.002 |
| La Crosse | | 0.22[c] | 54 | 0.012 | 0.003 |
| Madison | 0.5[g] | | 184 | 0.042 | 0.021 |
| Manitowac | | 0.1[e] | 33.299 | 0.008 | 0.001 |
| Marshfield | | 0.22[c] | 15.625 | 0.004 | 0.001 |
| Menasha | | 0.5[b] | 14.8 | 0.003 | 0.002 |
| Menomonee Falls | | 0.1[e] | 17.083 | 0.004 | 0.000 |
| Merrill | | 0.8[h] | 10 | 0.002 | 0.002 |
| Milwaukee | 0.1[g] | | 933 | 0.211 | 0.021 |
| Neenah | | 0.5[b] | 25 | 0.006 | 0.003 |
| Oshkosh | | 0.5[b] | 52 | 0.012 | 0.006 |
| Racine | | 0.1[e] | 100 | 0.023 | 0.002 |
| Sheboygan | | 0.1[e] | 47.957 | 0.011 | 0.001 |
| Shorewood | | 0.1[e] | 16 | 0.004 | 0.000 |
| Stevens Point | | 0.8[h] | 23.494 | 0.005 | 0.004 |
| Superior | 4.3[i] | | 32.5 | 0.007 | 0.030 |
| Two Rivers | | 0.1[e] | 13.553 | 0.003 | 0.000 |
| Waukesha | | 0.1[e] | 40.258 | 0.009 | 0.001 |
| Wausau | | 0.8[h] | 33 | 0.007 | 0.006 |
| West Allis | 0.1[i] | | 71 | 0.016 | 0.002 |
| Wisconsin Rapids | | 0.8[h] | 18.583 | 0.004 | 0.003 |
| Nonurban | | 0.22[c] | 2242.778 | 0.508 | 0.112 |
| Total | | | | | 0.249 |

Population-weighted average concentration (μg/L) = 0.249
(pCi/L) = 0.169

Estimated per capita bone dose
Model I 0.249 × 10.2 = 3 mrem/year
Model II 0.249 × 0.381 = <1 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-0.4
10 pCi/L = 0-0.6
5 pCi/L = 0-2
1 pCi/L = 3-9

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[a] 1970 Census.

[b] Equal to Kaukauna in Scott and Barker, 1962.

[c] Average of second most frequently occurring concentration range in domestic water histogram. Mode is 0-0.01 pCi/L.

[d] Equal to Roberts in Scott and Barker, 1962.

[e] Equal to Milwaukee in Durfor and Becker, 1964.

[f] Equal to Beloit in Scott and Barker, 1962.

[g] Durfor and Becker, 1964.

[h] Equal to Vesper in Scott and Barker, 1962.

Table A2.51. Wyoming (total population 332 416[a])

| City or utility | Uranium in treated water (μg/L)<br>Measured | <br>Estimated | Population served[a] (thousands) | Population weighting factor | Population adjusted contribution to state average |
|---|---|---|---|---|---|
| Casper | | 0.7[b] | 41 | 0.123 | 0.086 |
| Cheyenne | 1.5[c] | | 50 | 0.150 | 0.225 |
| Nonurban | | 5.1[d] | 241.416 | 0.726 | 3.703 |
| Total | | | | | 4.014 |

Population-weighted average concentration (μg/L) = 4.014
(pCi/L) = 2.730

Estimated per capita bone dose
Model I 4.014 × 10.2 = 41 mrem/year
Model II 4.014 × 0.381 = 2 mrem/year

Percent of water supplies exceeding 20 pCi/L = 0-9
10 pCi/L = 0-16
5 pCi/L = 0-29
1 pCi/L = 50-80

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[a] 1970 Census.

[b] Equal to Edgerton in Scott and Barker, 1962.

[c] Scott and Barker, 1962.

[d] Average of most frequently occurring concentration range in domestic water histogram.

# APPENDIX 3

## ESTIMATION OF LIFETIME BONE DOSE OF ALPHA RADIATION DUE TO URANIUM IN DRINKING WATER

Two separate estimates were made of the lifetime bone dose of alpha radiation due to uranium in the drinking water of each state. Both estimates were based on the previously computed population-weighted average concentration of uranium in the state's drinking water. The first estimate (Model I) was derived from an exposure-dose relationship supplied by the ODW [185]. This formula equated a 70-year, 2 L/d consumption of water containing 10 pCi/L uranium with a 150-mrem/year bone dose of alpha radiation, assuming a normal distribution of isotopic species.

The second bone dose estimate (Model II) was based on the relationship that a 50-year, daily ingestion of 2 liters of water containing 1 pCi/L of $^{238}U$ plus daughters would result in a bone dose of 0.56 mrem/year [194]. Estimates of bone dose based on Model II are smaller than those computed for Model I by a factor of 25. An assessment of the validity of the models used is beyond the scope of this report; however, some discussion of the assumptions involved in the Model II calculation may be found in the cited reference.

The SI unit for absorbed dose is the Sievert (Sv). The Sievert is related to the rem in the following way: 100 rem equal 1 Sv.

# APPENDIX 4

## ESTIMATION OF WATER SUPPLIES EXCEEDING GIVEN CONCENTRATIONS

For administrative purposes it is desirable to know the fraction of U.S. water supplies likely to be affected by regulating uranium concentrations in drinking water at a given level. A rigorous determination obviously requires analytical data for each water supply. Unfortunately, such data do not exist. However, we have prepared estimates by two different techniques which appear to define a useful range of values. The first estimate is based on the measured or assigned values of uranium in the water of the 768 AWWA water supplies listed in Appendix 2 of this volume. From a statistical point of view this procedure is limited because of the small number of water supplies for which data are available. Nevertheless, in the absence of firm analytical data, estimates derived from these numbers appear useful. A second method of estimating the fraction of water supplies impacted by regulating uranium at a given level can be based on the assumption that the distribution of water supplies having a given uranium concentration varies as the distribution of uranium concentrations in the domestic water histogram of each state. Generally speaking, there is a sufficient number of samples in each histogram to provide an adequate estimate from a statistical point of view. In practice, the two techniques agree reasonably well, with the first tending to provide a lower value than the second. We have recorded the results of both methods in the form of a range for concentrations of 1, 5, 10, and 20 pCi/L.